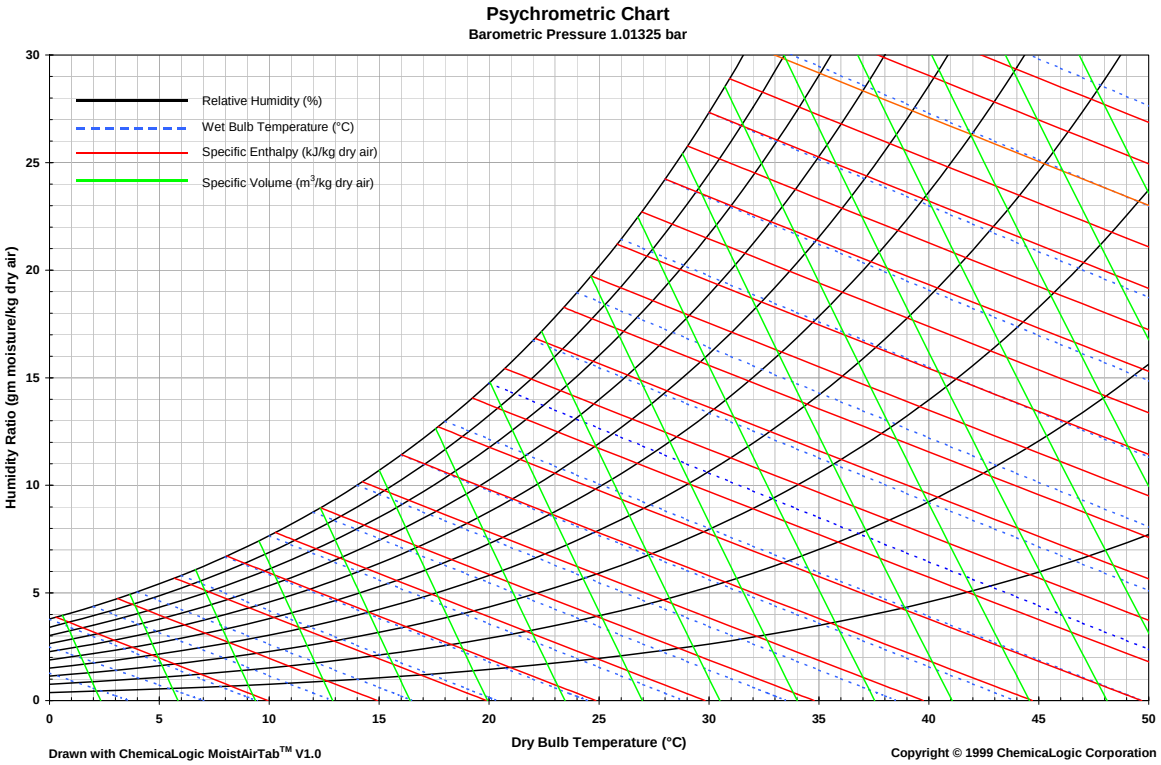
MoistAirTab V2.0 User's Guide

THERMODYNAMIC AND TRANSPORT PROPERTIES OF MOIST AIR (PSYCHROMETRICS)



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MoistAirTab™ Thermodynamic and Transport Properties of Moist Air (Psychrometrics)

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Table of Contents

List of Figures

Chapter 1

Getting Started

Overview and Features

MoistAirTab™ brings you a comprehensive set of moist air (humid air) properties — right in your spreadsheet — with "live" links to variable psychrometric conditions by cell reference. You never again have to copy or re-type any property values into your spreadsheet!

MoistAirTab™ is indispensable for professionals working in the field of air conditioning, power generation, paper and pulp, food processing, desiccant drying, compressor design and chemical process engineering.

Some of the unique features of MoistAirTab are:

- Direct "live" links to variable psychrometric conditions by cell reference
- Built-in MoistAirTab™ worksheet functions and user-interface dialog-boxes
- Choice of Metric/SI or English units
- Includes all standard psychrometric properties, as well as steam, water and ice properties
- Generate your own psychrometric charts and tables
- Save property values for export to other applications – limited only by the spreadsheet's file transfer capability
- Spreadsheet simulators for moisture content expressions, streams mixing, heating, cooling, humidification, air dehydration, solids drying, multi-stage air compressor are included as examples
- Allows multiple -input specifications – up to 18 combinations of input variables. First independent variable can be either: Dry-bulb temperature (*Tdb*), Humidity Ratio (*W*), or Relative Humidity (*RH*). Second independent variable can be either: Dry-bulb Temperature (*Tdb*), Wet-bulb Temperature (*Twb*), Humidity Ratio (*W*), or Relative Humidity (*RH*), Enthalpy (*H*), Entropy (*S*), or Volume (*V*)

Calculation results using MoistAirTab can be freely formatted and charted for presentation

MoistAirTab uses an equation of state to compute all of the thermodynamic properties. MoistAirTab uses formulations that are approved by the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) as documented in the 1997 ASHRAE Handbook: Fundamentals. The equation-of-state used to compute the moist air properties are given in:

Reference

Formulations for the thermodynamic properties of the saturated phases of H2O from 173.15 K to 473.15 K, W. Hyland and A. Wexler, ASHRAE Transactions, Vol. 89, No. 2A, pp. 500-519, 1983.

Formulations for the thermodynamic properties of dry air from 173.15 K to 473.15 K, and of saturated moist air from 173.15 K to 372.15 K, at pressures to 5 MPa, R. W. Hyland and A. Wexler, ASHRAE Transactions, Vol. 89, No. 2A, pp. 520-535, 1983.

The range of validity for the properties of moist air is:

Pressure: $0 \le P\ (bar) \le 50$, or
$0 \le P\ (psi) \le 725$

Temperature: $-100 \le T\ (C) \le 372$, or
$-148 \le T\ (F) \le 701$

What's New in Version 2.0

MoistAirTab Version 2.0 offers a number of enhancements:

- MoistAirTab V2.0 supports Excel versions 2003, 2007 and 2010 running on Windows XP and later.
- Supports both 32-bit and 64-bit Excel 2010.
- Includes automatic installation (and uninstalling) on the supported platforms.
- The temperature range has been increased from 200ºC to 372ºC

- The ability to use a numeric property code as well as a mnemonic string (the string version is *case insensitive*). For example, to calculate the enthalpy of moist air you can use either 19 or "Hm".

- Added over 20 new properties for moist air, including transport properties and mass transfer properties.

Technical Support and Contact Information

ChemicaLogic offers free technical support with the purchase of MoistAirTab. If you have any problems during installation or use of MoistAirTab, please contact us at one of the addresses listed below.

Before requesting support, it would save both your time and our time if you could first do the following:

- Make sure you have read any relevant portions of the manual
- Isolate the problem to a small test case
- Have the version number of your copy of MoistAirTab ready
- Have the version number of the spreadsheet application and the operating system on which it is installed ready

You can contact us via any of the following paths:

By Telephone:	781.425.6738 (9 AM to 5 PM, EST)
By Fax:	781.425.6741
By Email:	clc.support@chemicalogic.com
By Web:	http://www.chemicalogic.com
By Mail:	ChemicaLogic Corporation 99 South Bedford Street, Suite 207 Burlington, Massachusetts 01803 USA

Minimum System Requirements

You should not encounter any hardware or software problems in using MoistAirTab on any hardware that has one of the following spreadsheet applications pre-installed:

- Microsoft Excel 2003 or later running on Windows XP or later (32-bit and 64-bit operating systems are both supported).

Installation

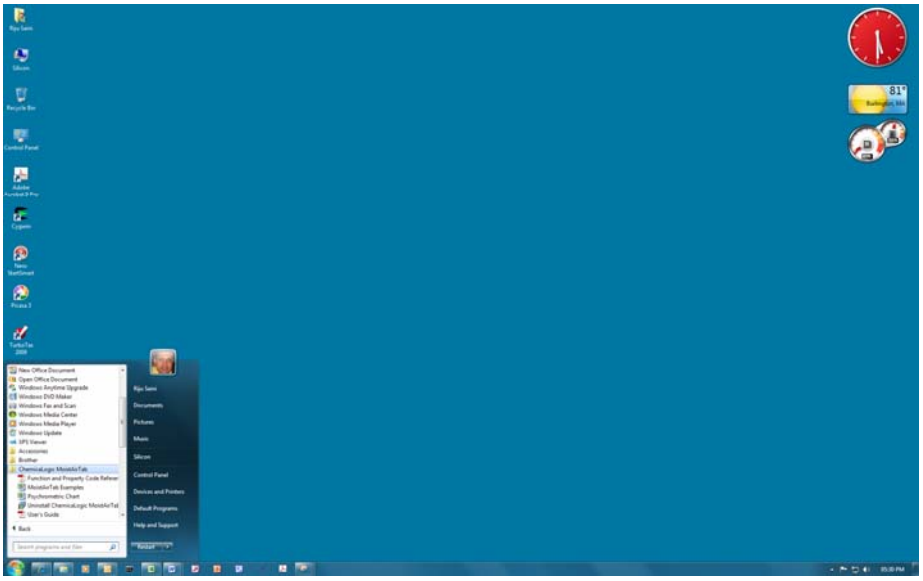
MoistAirTab contains an automatic installation program that will install the add-in within Excel as well as certain example files, document files and the online help file.

To install MoistAirTab, simply click on the file `SETUP-MOISTAIRTAB.EXE` and follow the instructions on the screen.

> **Note**
>
> Before installing MoistAirTab on your machine, please make sure that Excel is **not** running.

Once installation is complete you can access MoistAirTab from Excel. If you need to access the User's Guide and other documents at are installed, go to Window's Start menu, click on Programs and you should see a folder called ChemicaLogic MoistAirTab as shown below:

Figure 1: ChemicaLogic MoistAirTab on Window's Start Menu



Using MoistAirTab

The following sections describe how to access and use the various features of MoistAirTab.

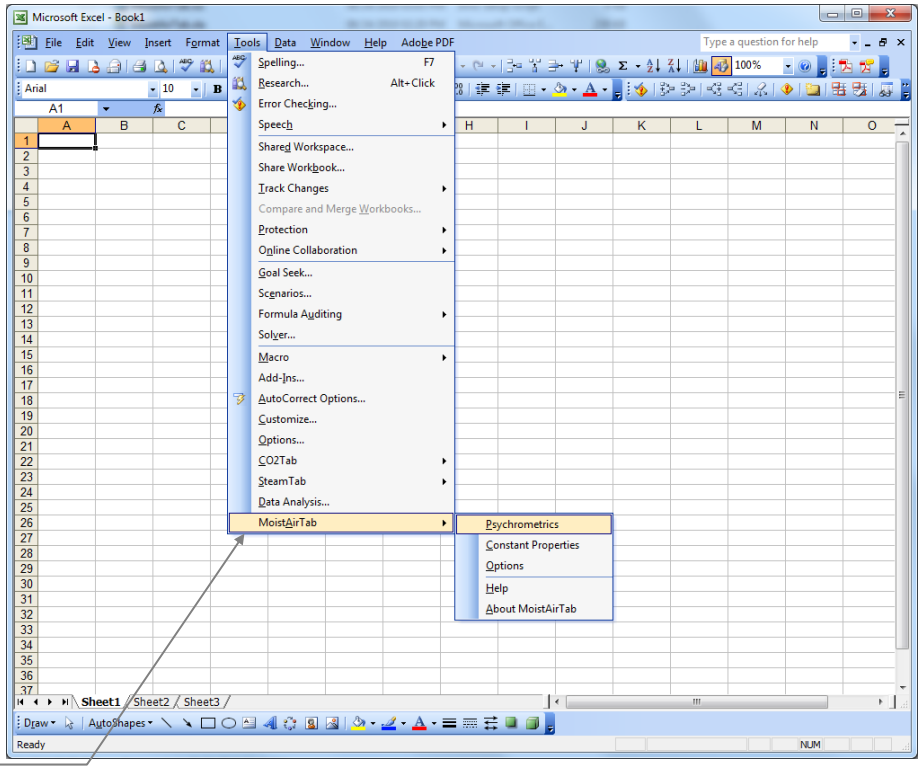
Where is MoistAirTab?

As an add-in package to your spreadsheet application, MoistAirTab quietly becomes a part of your spreadsheet. You only see it when you need to use it. Just to make sure that MoistAirTab is available,

1. Start your spreadsheet application (if you have not already started it)
2. Excel 2003 Users: Click on the Tools menu. You should see a MoistAirTab pop-up menu somewhere near the bottom of the Tools menu
   Excel 2007 or 2010 Users: Click on the Add-ins ribbon and you will see the MoistAirTab menu.
3. Expand the MoistAirTab pop-up menu by clicking on it
4. The following figures show what you should see

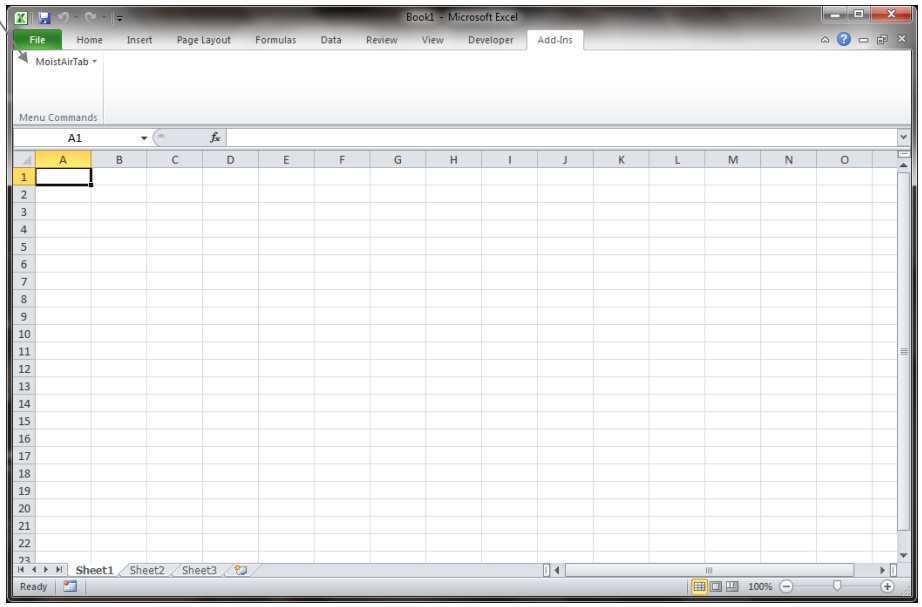
A pop-up menu (which is also known as a drop-down menu) is a special menu item that displays a sublist of menu items when it is selected.

Figure 2: Access to MoistAirTab in Excel 2003



MoistAirTab Menu

Figure 3: Access to MoistAirTab in Excel 2007 or Excel 2010



The MoistAirTab pop-up menu contains the following menu items:

1. Psychrometrics
   Selecting this menu item brings up the psychrometrics dialog box which helps you obtain the moist air properties at varying input conditions.
2. Constant Properties
   Selecting this menu item brings up the constant properties dialog box which you can use to select the required constant moist air property.
3. Options
   This menu item allows you to select the units and other configuration options. You can also change the units and model formulation from any of the MoistAirTab dialog-boxes.
4. Help
   Provides you with easy access to online help.
5. About MoistAirTab
   Gives you information regarding the version of MoistAirTab installed on your machine.

The following sections describe how to use the various capabilities of MoistAirTab.

Setting MoistAirTab Options

The options dialog box helps you in setting up the units to base your property calculations. All of the MoistAirTab dialog-boxes use the same options that you specify from the option dialog box.

If you are using the Worksheet functions directly in you spreadsheet, then you do not have to set the options. The options dialog is only used by the MoistAirTab dialog boxes.

You can access the MoistAirTab options from either the MoistAirTab pop-up menu or from any of the other MoistAirTab dialog boxes.

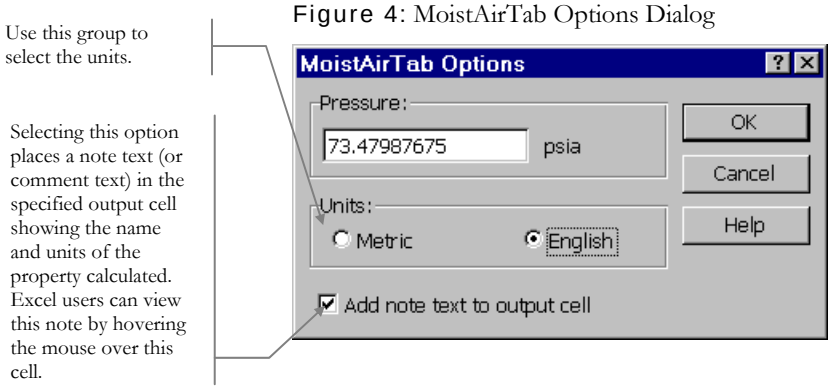
Use the following steps to set the MoistAirTab options (see Figure 4 for an illustration of the MoistAirTab options dialog box):

1. Select units
   Select the Metric radio button if you want properties in Metric/SI units or select the English radio button for properties English units.
2. Select comment option
   Check the comments box if you want MoistAirTab to place a comment regarding the property calculated and the units in the output cell.
3. Select Pressure
   You can enter a default pressure to be used by all of the dialog boxes. Note that you can override the default pressure in the psychrometric dialog box.

4. Click OK
   Click on the OK button to accept the changes. After you have clicked OK, all of the MoistAirTab dialog-boxes will use the specified units options.

> **Note**
>
> If you typically work with only one set of options, you need to only specify them once. MoistAirTab will remember the options even in subsequent sessions.

Figure 4: MoistAirTab Options Dialog



Using the Psychrometric Dialog Box

The psychrometric dialog-box helps you obtain the moist air properties at varying input conditions.

See the Chapter: Function Reference on page 16 for a description of MoistAirTab functions

This dialog box automatically creates a call (with all the correct arguments) to the appropriate MoistAirTab function based on the input parameters you supply.

Use the following steps to calculate a saturated steam property (see Figure 5 for an illustration of the psychrometrics dialog box):

1. Select Options
   Click on the Options button to bring up the options dialog-box from where you can select the units, as described in the previous section. If you previously selected the units, you can skip this step.
2. Select input data
   Use the drop-down box to select the type of independent variables to specify. Enter a cell reference (or point to a cell reference) in each of the input variables.

Depending on your choice of units and independent variable, the value text will show you the units in which the value is required

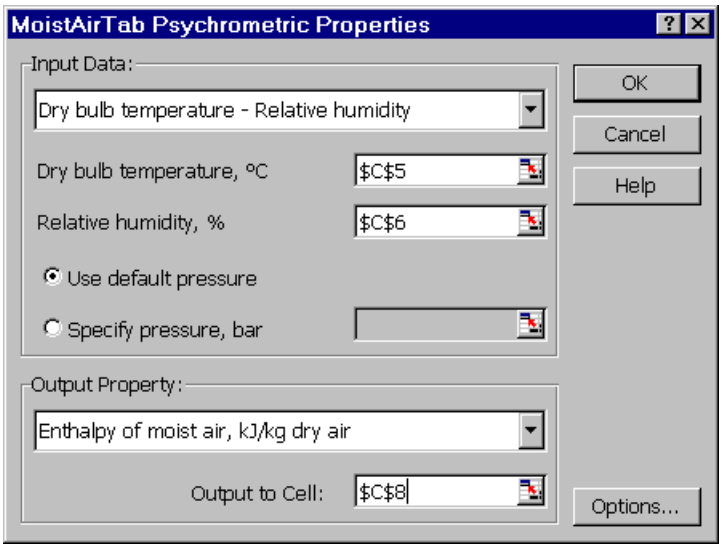
1. Provide a value for the pressure (optional)
   Optionally provide a value for the pressure or use the default value.
2. Select moist air property required
   Using the drop-down combo-box, select the property you want. Use the mouse or the cursor keys to scroll through the list of available steam properties until you come to the one you desire.

Tip: Click on a cell where you want the results before opening the saturated dialog box. MoistAirTab will automatically fill in the Output cell reference

1. Provide an output cell reference
   Notice that MoistAirTab has already filled this in with the currently selected cell reference. If this is not where you want the results to go, select or type in a different cell reference.
2. Click OK
   MoistAirTab will calculate the requested steam property and place it in the specified output cell as a formula.

If you want a different moist air property, simply repeat the above steps. Alternatively, you could copy the cell containing the saturated steam property function and paste it in the location you want. You can then use the saturated dialog box to change the output steam property.

Figure 5: Psychrometric Properties Dialog (Excel versions)



Using the Constant MoistAirTab Properties Dialog Box

The constant properties dialog box gives you access to fundamental moist air properties, such as, molecular weights and property ranges.

The following steps illustrate how to use this dialog box (see the figure below for an illustration of this dialog box):

1. Select Options
   Click on the Options button to bring up the options dialog-box from where you can select the units, as described in the previous section. If you previously selected the units, you can skip this step.
2. Select constant property required
   Using the drop-down combo-box, select the constant property you want. Use the mouse or the cursor keys to scroll through the list of available steam properties until you come to the one you desire.

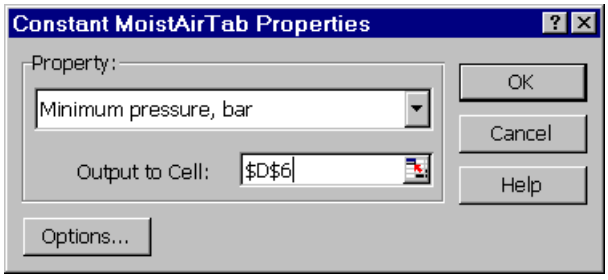
Tip: Click on a cell where you want the results before opening this dialog box. MoistAirTab will automatically fill in the Output cell reference

1. Provide an output cell reference
   Notice that MoistAirTab has already filled this in with the currently selected cell reference. If this is not where you want the results to go, select or type in a different cell reference.
2. Click OK
   MoistAirTab will calculate the requested steam property and place it in the specified output cell as a formula.

If you want a different constant property, simply repeat the above steps. Alternatively, you could copy the cell containing the constant property function and paste it in the location you want. You can then use the constant properties dialog box to change the output steam property.

The following figure illustrates the above steps for the Excel versions of MoistAirTab.

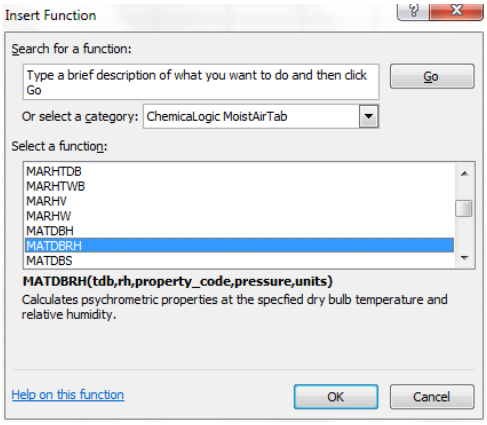
Figure 6: Constant Property Dialog Box



Using Excel's Function Wizard

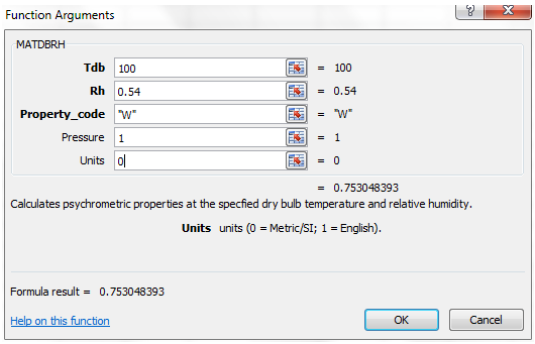
If you know the MoistAirTab function that you want to use, you can use Excel's function wizard to generate the function call. MoistAirTab installs all of the functions defined in a category called ChemicaLogic MoistAirTab as shown below:

Figure 7: ChemicaLogic MoistAirTab functions in Excel's Function Wizard



Selecting the MATDBRH to generate psychrometric properties at the specified dry bulb and wet bulb temperatures shows the function wizard:

Figure 8: Excel's Function Wizard for MoistAirTab Function



If you need help on the function arguments or need to lookup the property codes click on the "Help on this function" located on the lower left corner of the function wizard.

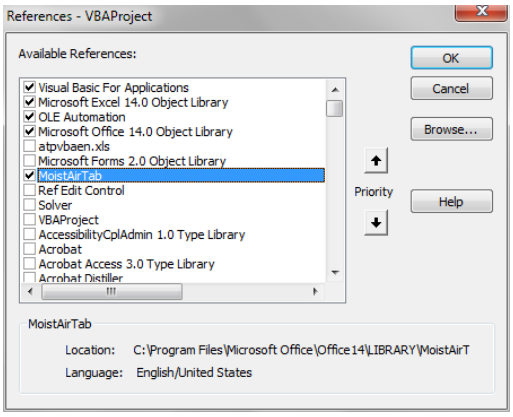
Using MoistAirTab in Excel's Visual Basic for Applications (VBA)

You can also use the MoistAirTab functions in you own macros or functions in Excel's VBA. But before you use the MoistAirTab functions, you need to establish a reference to the add-in from the VBA editor.

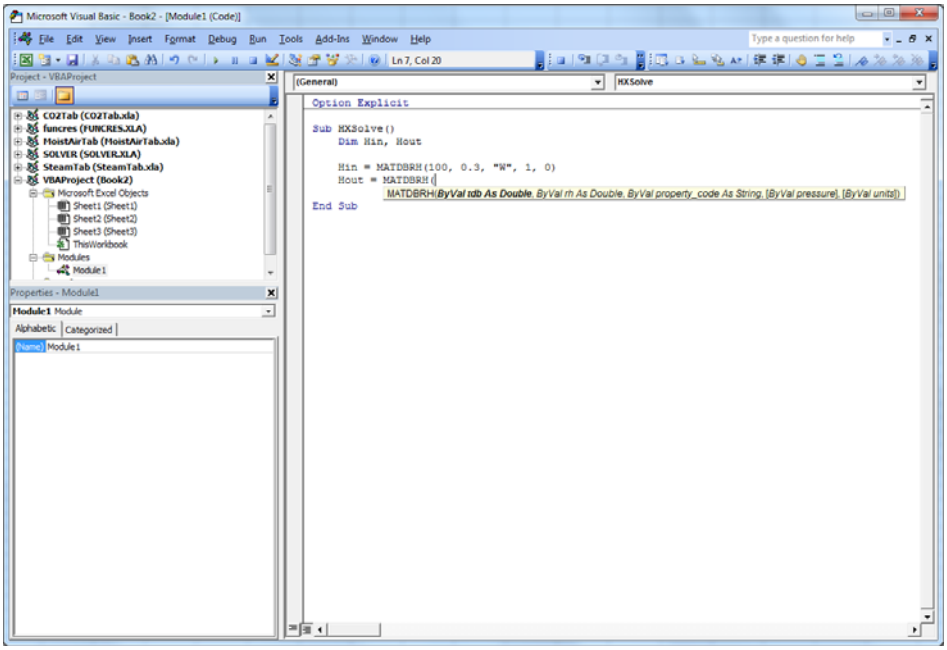
To establish a reference to the MoistAirTab add-in, start the VBA editor in Excel 2003 from the Tools, Macro, Start Visual Basic Editor (or press the Alt+F11 keys) or in Excel 2007/2010 from the Developer tab select Visual Basic (if you do not see the Developer tab, please refer to this document on how to show the Developer tab: http://msdn.microsoft.com/en-us/library/bb608625.aspx). The Visual Basic editor comes up and from the

Tools menu Select References and place a check mark next to MoistAirTab and select OK:

Figure 9: Excel VBA Reference to MoistAirTab



Once a reference to MoistAirTab is established you can use the MoistAirTab functions in VBA just as you would any other function, as shown below:



FAQ: Frequently Asked Questions

How do I input the value for Relative Humidity in MoistAirTab?
The relative humidity is defined as a fraction between 0 and 1. To enter the relative humidity, either use a number between 0 and 1, or enter it as a

percentage, e.g. 25.4% (Please note that you must include the percent symbol % after the number – in Excel, a percent is always represented as a fraction).

The numbers generated with MoistAirTab do not match my psychrometric chart in English units. However, the Metric/SI numbers match. What's going on?

There are two possibilities for this:

1. You may have changed the Units specification from Metric/SI to English from the Options dialog-box. Please make sure that the Default Pressure is set at the correct value in the selected unit. MoistAirTab does not automatically convert the value of the default pressure when the unit is switched. For example, the default pressure is 1 bar in Metric/SI units. When you change the units to English, the default pressure value remains 1, while the "Unit" has changed to psia. But in the mean time, you need to specify the default pressure value in psia unit, e.g. 14.69.

2. Even when you make the above change, you may still notice differences between printed psychrometric charts in English units versus the numbers generated by MositAirTab in Enthalpy and Entropy values. The reason is that some versions of printed charts use a different reference state for defining the thermodynamic path functions. For example, the popular Psychrometric Chart published by Carrier Corporation in 1947 and 1959 in English units use 0ºF as the reference temperature whereas MoistAirTab uses 0ºC (32ºF) as the reference temperature (as recommended by ASHRAE). Please note that the choice of a reference state is arbitrary and should not affect the end result when using either the printed chart or MoistAirTab as one normally only deals with the changes in enthalpy and entropy rather than the absolute quantities.

   For those who prefer to use the English units (I-P units) and insist that 0ºF be used as the reference temperature for enthalpy and entropy, please note that the numeric difference between 32ºF and 0ºF is 7.686951 Btu/lb-dry-air in enthalpy and 0.016166 Btu/lb-dry-air/ºF in entropy. To shift the enthalpy or entropy value from 32ºF to 0ºF you only need to add the value noted above from the enthalpy or entropy value obtained from the MoistAirTab. No shift is needed for other properties.

When I copy MoistAirTab generated formulae to different cells, they just repeat the same calculation. How do I remove the hard anchored cell reference when I copy a MoistAirTab function?
The "$" used in the formula is a convention shared by all spreadsheets for anchoring the cell reference to the row, the column or both (a fixed cell location). As a spreadsheet add-in, the MoistAirTab complies with the rules and conventions of the host spreadsheet.

MoistAirTab anchors all cell references to fixed cell locations by fixing both column and row locations ($Column$Row). When you wish to copy formulae with cell references, depending on your formulation, you will need to modify the anchors by removing either one or both of the "$" signs before copying the formula. If you single click the left mouse bottom when the mouse pointer is placed on the cell reference (for example, B12) in the formula bar on top of your Excel spreadsheet, and toggle the 4-way **F4** key on your keyboard, you will see that the fixed cell reference is first changed to fixed column reference. Toggle again, changed to fixed row reference. Toggle once more, changed to no anchoring. Toggle once again, changed back to fixed cell reference. Alternatively, you could just go into the formula and delete the unwanted $ signs before copying the formula.

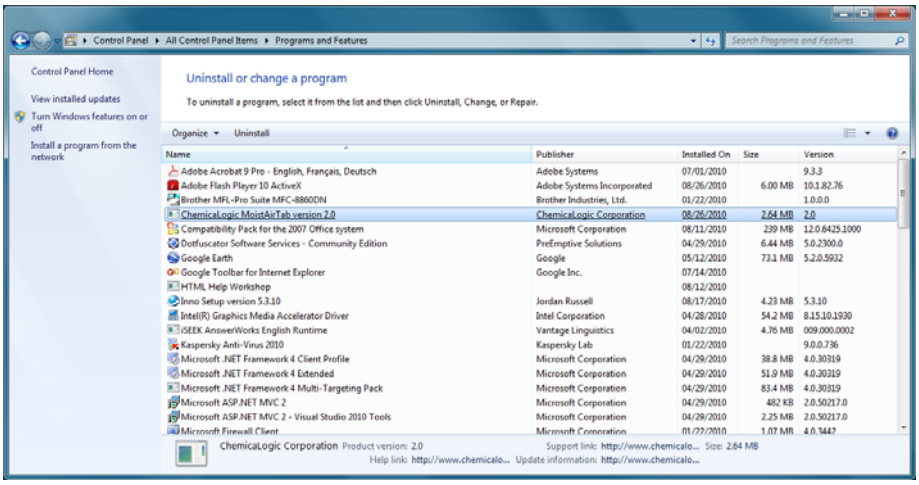
Why doesn't MoistAirTab allow entering values directly in the function dialog-box (as does SteamTab)?
This is intentional. Our experience in spreadsheet engineering has taught us that when we embed values directly into formulae, it becomes more difficult later to recreate the logic or debug the algorithm, since we only see the result of the formula, instead of a full description of input parameters. Referencing a cell reference for input to a formula not only documents our data source, but also allows Excel's auditing tools to track all precedents and dependents thereby aiding debugging.

If you insist, you can directly input the value, but you will need to put up with some annoying Excel behavior. When you enter a value in any of the edit boxes, Excel will warn you that the cell reference in incorrect. Since you know better, simply ignore it and Excel will still proceed to compute the results.

Uninstalling MoistAirTab

To uninstall MoistAirTab, from Window's Start menu, select Programs, ChemicaLogic MoistAirTab and then select Uninstall ChemicaLogic MoistAirTab. This will completely uninstall MoistAirTab from your computer.

You can also uninstall MoistAirTab from the Control Panel, Add or Remove Programs (or Programs and Features in Windows 7) and selecting ChemicaLogic MoistAirTab version 2.0 to uninstall.



Chapter 2

Function Reference

Overview

The MoistAirTab add-in package is based on a set of 19 core functions that together calculate over 46 thermodynamic and transport properties of steam. You can use these functions directly in your spreadsheet or you can use MoistAirTab's easy-to-use dialog boxes to automatically generate the appropriate function call with the correct arguments.

All of the MoistAirTab functions begin with the prefix MA. The MoistAirTab functions require as input two independent variables in addition to the total pressure (absolute). The first independent variable can be either: Dry bulb temperature (*Tdb*), Humidity Ratio (*W*), or Relative Humidity (*RH*). The second independent variable can be either: Dry-bulb Temperature (*Tdb*), Wet-bulb Temperature (*Twb*), Humidity Ratio (*W*), or Relative Humidity (*RH*), Enthalpy (*H*), Entropy (*S*), or Volume (*V*). These functions are summarized in below.

MoistAirTab also includes functions for obtaining the barometric pressure and temperature as a function of altitude. A number of additional functions are provided that compute certain constant properties of air and water.

Note

All MoistAirTab functions begin with the prefix **MA**.

Functions for Psychrometric Properties

MoistAirTab provides 19 functions that compute the specified psychrometric property at specified two independent variables in addition to the atmospheric pressure (absolute). The psychrometric property codes are:

Table 1: Psychrometric Property Codes

Code		Property	Metric/SI Units	English Units
0	Tdb	Dry bulb temperature	°C	°F
1	Twb	Wet bulb temperature	°C	°F
2	Tdew	Dew point temperature	°C	°F
3	P	Pressure	bar	psia
4	Pws	Saturation water vapor pressure	bar	psia
5	Pwet	Saturation pressure at wet bulb temperature	bar	psia
6	Pdew	Saturation pressure at dew point temperature	bar	psia
7	Xw	Water mole fraction	mol%	mol%
8	Xa	Air mole fraction	mol%	mol%
9	Mw	Water weight fraction	wt%	wt%
10	Ma	Air weight fraction	wt%	wt%
11	W	Humidity ratio	dimensionless	dimensionless
12	Ws	Saturation humidity ratio	dimensionless	dimensionless
13	RH	Relative humidity	%	%
14	Va	Volume of dry air	m^3/kg dry air	ft^3/lb dry air
15	Vm	Volume of moist air	m^3/kg dry air	ft^3/lb dry air
16	Vw	Volume of condensed water or ice	m^3/kg	ft^3/lb
17	Vg	Volume of steam	m^3/kg	ft^3/lb
18	Ha	Enthalpy of dry air	kJ/kg dry air	Btu/lb dry air
19	Hm	Enthalpy of moist air	kJ/kg dry air	Btu/lb dry air
20	Hw	Enthalpy of condensed water or ice	kJ/kg	Btu/lb
21	Hg	Enthalpy of steam	kJ/kg	Btu/lb
22	Sa	Entropy of dry air	kJ/(kg dry air.°C)	Btu/(lb dry air.°F)
23	Sm	Entropy of moist air	kJ/(kg dry air.°C)	Btu/(lb dry air.°F)
24	Sw	Entropy of condensed water or ice	kJ/(kg.°C)	Btu/(lb.°F)
25	Sg	Entropy of steam	kJ/(kg.°C)	Btu/(lb.°F)
26	Cpa	Heat capacity at constant pressure of dry air	kJ/(kg.°C)	Btu/(lb.°F)
27	Cpm	Heat capacity at constant pressure of moist air	kJ/(kg.°C)	Btu/(lb.°F)
28	Cpw	Heat capacity at constant pressure of water	kJ/(kg.°C)	Btu/(lb.°F)
29	Cpg	Heat capacity at constant pressure of steam	kJ/(kg.°C)	Btu/(lb.°F)
30	Mua	Viscosity of dry air	Pa.s	lb/(ft.hr)
31	Mum	Viscosity of moist air	Pa.s	lb/(ft.hr)
32	Muw	Viscosity of water	Pa.s	lb/(ft.hr)
33	Mug	Viscosity of steam	Pa.s	lb/(ft.hr)
34	Ka	Thermal conductivity of dry air	W/(m.°C)	Btu/(hr.ft.°F)
35	Km	Thermal conductivity of moist air	W/(m.°C)	Btu/(hr.ft.°F)
36	Kw	Thermal conductivity of water	W/(m.°C)	Btu/(hr.ft.°F)
37	Kg	Thermal conductivity of steam	W/(m.°C)	Btu/(hr.ft.°F)
38	Pra	Prandtl number of dry air	dimensionless	dimensionless
39	Prm	Prandtl number of moist air	dimensionless	dimensionless
40	Prw	Prandtl number of water	dimensionless	dimensionless
41	Prg	Prandtl number of steam	dimensionless	dimensionless
42	Daw	Diffusivity of water vapor in air	m^2/s	ft^2/hr
43	Scm	Schmidt number of moist air	dimensionless	dimensionless
44	Rho	Density of moist air	kg/m^3	lb/ft^3
45	Ds	Degree of saturation	dimensionless	dimensionless

Note

You can use either the numeric property code or the string version of the property code (the string version is *case insensitive*). For example, to calculate the enthalpy of moist air you can use either 19 or "Hm"

These functions are described in greater detail below.

MATDBTWB

Calculates the psychrometric property at the specified dry bulb temperature and wet bulb temperature.

Syntax

MATDBTWB(Tdb, Twb, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
Twb	is the wet bulb temperature (ºC or ºF).
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBRH

Calculates the psychrometric property at the specified dry bulb temperature and relative humidity.

Syntax

MATDBRH(Tdb, RH, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
RH	is the relative humidity (a fractional number between 0 and 1).
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBW

Calculates the psychrometric property at the specified dry bulb temperature and humidity ratio.

Syntax

MATDBW(Tdb, W, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
W	is the humidity ratio.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBH

Calculates the psychrometric property at the specified dry bulb temperature and specific moist air enthalpy.

Syntax

MATDBH(Tdb, H, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
H	is the specific moist air enthalpy.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBS

Calculates the psychrometric property at the specified dry bulb temperature and specific moist air entropy.

Syntax

MATDBS(Tdb, S, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).

S	is the specific moist air entropy.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBV

Calculates the psychrometric property at the specified dry bulb temperature and specific moist air volume.

Syntax

MATDBV(Tdb, V, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
V	is the specific moist air volume.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATDBTDEW

Calculates the psychrometric property at the specified dry bulb temperature and dew point temperature.

Syntax

MATDBW(Tdb, Tdew, property_code, pressure, *units*)

Arguments

Tdb	is the dry bulb temperature (ºC or ºF).
Tdew	is the dew point temperature (ºC or ºF).
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWTWB

Calculates the psychrometric property at the specified humidity ratio and wet bulb temperature.

Syntax

MAWTWB(W, Twb, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
Twb	is the wet bulb temperature (ºC or ºF).
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value

of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWTDB

Calculates the psychrometric property at the specified humidity ratio and dry bulb temperature.

Syntax

MAWTDB(W, Tdb, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
Tdb	is the dry bulb temperature (ºC or ºF).
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWRH

Calculates the psychrometric property at the specified humidity ratio and relative humidity.

Syntax

MAWRH(W, RH, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
RH	is the relative humidity (a fractional number between 0 and 1).
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWH

Calculates the psychrometric property at the specified humidity ratio and specific moist air enthalpy.

Syntax

MAWH(W, H, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
H	is the specific moist air enthalpy.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWS

Calculates the psychrometric property at the specified humidity ratio and specific moist air entropy.

Syntax

MAWS(W, S, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
S	is the specific moist air entropy.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAWV

Calculates the psychrometric property at the specified humidity ratio and specific moist air volume.

Syntax

MAWV(W, V, property_code, pressure, *units*)

Arguments

W	is the humidity ratio.
V	is the specific moist air volume.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes

(page 17) for a listing of valid property codes.

pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHTWB

Calculates the psychrometric property at the specified relative humidity and wet bulb temperature.

Syntax

MARHTWB(RH, Twb, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).
Twb	is the wet bulb temperature.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHTDB

Calculates the psychrometric property at the specified relative humidity and wet bulb temperature.

Syntax

MARHTDB(RH, Tdb, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).
Tdb	is the dry bulb temperature.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHW

Calculates the psychrometric property at the specified relative humidity and humidity ratio.

Syntax

MARHW(RH, W, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).
W	is the humidity ratio.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHH

Calculates the psychrometric property at the specified relative humidity and specific moist air enthalpy.

Syntax

MARHH(RH, H, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).
H	is the specific moist air enthalpy.
property_code	is an integer or string property code that specifies the type of property required. See `Table 1`: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if ***units*** is 0; and must be in psia if ***units*** is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHS

Calculates the psychrometric property at the specified relative humidity and specific moist air entropy.

Syntax

MARHS(RH, S, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).

S	is the specific moist air entropy.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MARHV

Calculates the psychrometric property at the specified relative humidity and specific moist air volume.

Syntax

MARHV(RH, V, property_code, pressure, *units*)

Arguments

RH	is the relative humidity (a fractional number between 0 and 1).
V	is the specific moist air volume.
property_code	is an integer or string property code that specifies the type of property required. See Table 1: Psychrometric Property Codes (page 17) for a listing of valid property codes.
pressure	is the atmospheric pressure (absolute).
units	is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- The specified pressure unit must be in bar if *units* is 0; and must be in psia if *units* is 1.
- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

Functions for Constant Properties

The functions in this category return constant air or water properties as well as the temperature and pressure ranges for the formulation used to compute the psychrometric properties.

MAMWW

Returns the molecular weight of water.

Syntax

MAMWW(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAMWA

Returns the molecular weight of air.

Syntax

MAMWA(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATMIN

Returns the minimum dry bulb temperature that can be used.

Syntax

MATMIN(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATMAX

Returns the maximum dry bulb temperature that can be used.

Syntax

MATMAX(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAPMIN

Returns the minimum atmospheric pressure (absolute) that can be used.

Syntax

MAPMIN(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAPMAX

Returns the maximum atmospheric pressure (absolute) that can be used.

Syntax

MAPMAX(*units*)

Arguments

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MAPZ

Returns the atmospheric pressure (absolute) at the specified altitude or height above sea level.

Syntax

MAPZ(height, *units*)

Arguments

Height height above seal level (use a negative number for depth below sea level).

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error

MATZ

Returns the dry bulb temperature at the specified altitude or height above sea level.

Syntax

MATZ(height, *units*)

Arguments

Height height above seal level (use a negative number for depth below sea level).

Units is an integer argument (optional). For Metric/SI units, specify a value of 0 (or leave empty). For English units, specify a value of 1.

Remarks

- If any of the arguments are invalid or if the arguments are outside the acceptable bounds, the function returns #VALUE! error