

---

# **kW PSYCHROMETRIC FUNCTIONS LIBRARY**

## **Help Contents**

**Overview ..... 2**

**Using the Spreadsheet Templates ..... 3**

**Using the Psychrometric Functions ..... 4**

**Technical Notes ..... 6**

**Troubleshooting..... 7**

**About the kW Psychrometric Functions ..... 9**

**Copyright Notice ..... 10**

## Overview

The kW Psychrometric Functions software includes two basic parts:

- 1. The Add-In (PSYCH.XLA)**

The add-in allows you to do psychrometric calculations in any Excel spreadsheet (using Microsoft Excel 2003 or later). After you have installed the add-in, you can use psychrometric functions in calculations like you use other functions in Excel. For more information on how to use the functions, see **The Add-In (PSYCH.XLA)**

- 2. The Spreadsheet Templates (PSYCH.XLT & PSYCH\_SI.XLT)**

The spreadsheet templates use the add-in functions to create psychrometric charts. PSYCH.XLT is in inch-pound units and PSYCH\_SI.XLT is in metric units. The chart can easily be customized for altitudes (between -1,000 and 30,000 ft). The template also includes some example calculations and an easy method for adding your own data to the psych chart. You can use the spreadsheet template as a starting point for your own spreadsheets. For more information on how to use the template, see **The Spreadsheet Templates (PSYCH.XLT & PSYCH\_SI.XLT)**

**After installation, it is necessary to enable the kW Psychrometric Functions in Excel. For guidance enabling add-ins, please reference the Excel help file.**

## Using the Spreadsheet Templates

The spreadsheet templates (PSYCH.XLT & PSYCH\_SI.XLT) allow you to create new spreadsheets that include psychrometric charts. Select "File" and "New" from the Excel menu. Then select the "Spreadsheet Solutions" tab. Just double-click on the PSYCH.XLT and a new sheet will be created. Use PSYCH\_SI.XLT for a chart that uses metric (SI) units. Save it with a new name in your project directory.

The workbook includes a psychrometric chart that can be customized for any altitude up to 30,000 ft (or 10,000m). The following is a brief summary of the sheets in the spreadsheet template.

<b>Info</b>	General information and instructions
<b>Sheet1</b>	Sets the altitude and resulting pressure for calculations <b>(Don't delete this sheet!)</b>
<b>Examples</b>	Shows how the functions are used
<b>Data to Graph</b>	Tables to plot data on the psychrometric chart
<b>Psych Chart</b>	The psychrometric chart
<b>Plot Data</b>	Tables used to plot enthalpy and relative humidity lines on the chart (this sheet is hidden from view)

**Don't delete the Sheet1 page from the workbook if you want to use the chart.** Rename it instead. Sheet1 holds the value for the pressure at which the calculations are done for plotting enthalpy and relative humidity lines on the chart.

### Altitude / Pressure

Sheet1 contains a utility to update your psychrometric chart for any altitude from -1,000 ft to 30,000 ft above sea level. Just enter your altitude in the "Altitude" cell. The spreadsheet will automatically update the psychrometric chart.

If you want to use the psychrometric functions in existing spreadsheets, see **The Add-In (PSYCH.XLA)**

To copy the psychrometric chart to another spreadsheet unhide the "Plot Data" sheet and copy it, "Sheet1", "Data to Graph", and the "Psych Chart" tabs together to the other sheet.

## Using the Psychrometric Functions

The psychrometric functions work just like any other function in Microsoft Excel.

The functions in the library are the following:

Quality	Units (IP)	Units (SI)	Excel Function
Enthalpy	Btu/lb <sub>m</sub>	kJ/kg	enthalpy
Dewpoint Temperature	°F	°C	dewpoint
Relative Humidity	% (0.0 to 1.0)	% (0.0 to 1.0)	humidity
Humidity Ratio	lbs H <sub>2</sub> O/lbs dry air	kg H <sub>2</sub> O/kg dry air	humidratio
Specific Volume	ft <sup>3</sup> /lb	m <sup>3</sup> /kg	volume
Wet Bulb Temperature	°F	°C	wetbulb
Grains	grains	n/a	grains

Each function has the form:

***psychfunction***(T,P,Situation, StateVar,[UnitsSI])

where:

**T:** temperature [°F | °C]

**P:** pressure [psia | kPa]

**Situation:** tells the function which state variable you will supply  
(1 = WB, 2 = DP, 3 = RH, 4 = HR)

**StateVar:** the third state variable (i.e. WB, DP, RH, HR)

**UnitsSI:** *Optional*

tells the function which unit system to use for inputs and outputs  
TRUE = Metric (SI), FALSE = Inch-Pound (IP)  
If omitted, IP units are used

### Situations

1. When you know the wet bulb temperature [°F | °C]
2. When you know the dewpoint temperature [°F | °C]
3. When you know the relative humidity [% as decimal from 0 to 1.0]
4. When you know the humidity ratio [lbs H<sub>2</sub>O/lbs dry air | kg H<sub>2</sub>O/kg dry air]

## Shortcut

Excel makes using functions easier for you these days. The easy way to use the functions is to do the following:

- 1. Press the “Paste Function” button on the Standard Toolbar.**

The “Paste Function” button is labeled like this:  $f_x$

If you don't see the Standard Toolbar or the button, select “View | Toolbars | Standard” from the menu.

- 2. Choose “User Defined” in the Function category box.**

A list of functions will appear on the right. Double click on the one that you want to use. A function wizard window will come up to help you use the formula. Just follow the directions from there...

If the psychrometric functions do not appear in the "Paste Function" dialog box, check to ensure that the kW Psychrometric Function Add-in is turned on (select the menu item Tools | Add-Ins).

## Technical Notes

The functions are all based on correlations published in the 1997 ASHRAE Handbook of Fundamentals. These functions have not changed appreciably in recent updates to the AHSRAE Handbook of Fundamentals. According to ASHRAE "these relations are sufficiently accurate for most engineering calculations in air-conditioning practice..." Refer to 2009 Fundamentals, Chapter 1, under the heading "Numerical Calculation of Moist Air Properties" for more details.

There is some discrepancy among the functions in the evaluation of humidity ratio and relative humidity at low humidities and low temperatures. The properties calculated using dew point as a state variable do not agree precisely with quantities calculated using wet bulb temperature or relative humidity (which agree with each other very closely). The difference is small (i.e. less than 1%) within the ranges usually seen in HVAC applications. However it is significant at a relative humidity less than 30% and temperatures less than 45°F. This degree of error is built into the ASHRAE correlations and is not the result of our code. We are looking into the source of the discrepancy and will update our functions if a better solution is identified. Note that there is very good agreement among the functions (< 1% difference) in terms of evaluation of enthalpy anywhere on the psych chart.

## Troubleshooting

### Where do I put the PSYCH.XLA add-in?

There are two options for locating your add-in files.

1. Put the add-in in your Office Library Folder, usually located in your program files directory:

/Microsoft Office/Office ##/Library directory.

Where ## is the Microsoft version number:

- Office 2016 – 16
  - Office 2013 – 15
  - Office 2010 – 14
  - Office 2007 – 12
2. Update your add-in location from within Excel to point to the current location of PSYCH.XLA.

### My file will not open or the Excel calculations lock-up my computer

If either of these situations occur, it is likely that the Excel calculations use too many significant figures. The psychrometric calculation methodology used for this add-in are only accurate to  $\pm 0.7\%$ . Using too many significant figures may make the iteratively calculated variables get stuck.

### My file will not open or the Excel calculations lock-up my computer

When Excel add-in defined functions are copied between one workbook and another, Excel may insert an absolute reference into the formula. An absolute reference will look as follows:

```
='C:\Program Files\Microsoft Office\Office 15\LIBRARY\
PSYCH.XLA!Dewpoint(A12,$U$7,1,B12)
```

When opened on a different computer, Excel will follow the absolute file path rather than looking for the locally installed psychrometric function add-in. To avoid this issue, simply remove the file path, as follows:

```
=Dewpoint(A12,$U$7,1,B12)
```

### In Excel, the "Add-Ins" choice on my "Tools" menu is grayed-out. Why can't I select it?

The menu choice will not be available if you don't have a workbook open. Just open up a new blank sheet and the "Add-Ins" menu selection will be available again.

### Why do I get the error message "PSYCH.XLA is not a valid add-in"?

Check to verify that you are using Excel 2003 or later. The PSYCH.XLA may still be compatible with older versions of Excel (as old as Excel 97); however, versions of Excel older than the 2003 release are no longer supported.

### Why doesn't the "Calculate" message go away, even when I press F9?

This is an Excel bug. Pressing F9 (shortcut for "Calculate Now") or choosing "Calculate Now" from the "Tools | Options | Calculation" tab sometimes has no effect. Fortunately they give us

---

another option. Choose "Calc Sheet" on the "Tools | Options | Calculation" tab or press the shortcut key "<shift>F9".

### How do I add my own data to the Psych Chart?

The easy way is to start with one of the plots that is given in the spreadsheet template. Add your data on the "Data to Graph" tab. If you need to plot more than 10 points you can insert rows on the table and copy the humidity ratio functions (the column on the far right) into the empty cells. As long as you insert your rows in between the rows 1 through 10 on the table, the new data will show up on the graph. You can change the format of the points on the graph any way that you like.

You can also add data from your own table. The psych chart is an X-Y plot with dry bulb temperature (T) on the horizontal axis and humidity ratio (W) on the vertical axis. You need to manipulate your data into a table of T and W pairs to plot them. Bring up the "Psych Chart" sheet in the workbook and choose "Chart | Source Data" from the menu. Click on the tab labeled "Series" and push the "Add" button in the lower left corner. Put your cursor in the small window labeled "X Values:". Then you can select the range of temperatures in your data. Repeat the procedure to select humidity ratio data for the "Y Values:". You can also put in a title for your series. When you are done click "OK" and your data will be added to the plot. Sometimes it may be hard to spot at first. For some reason my version of Excel chooses an almost invisible color of green to plot the next series. You can use the "Zoom" feature to spot your series on the plot & change the color.

#### **NOTE: DON'T USE THE "ADD DATA" FUNCTION ON THE CHART MENU**

This function doesn't work well with the psych chart. Use the method described above instead.

## About the kW Psychrometric Functions

This is version 2.10 of the kW Psychrometric Functions. This update includes:

- Corrected functions in the Excel 2007 psychrometric templates, IP and SI units.
- Corrected Psychrometric Chart error in the SI units Excel 2003 psychrometric template that manifested as a macro error.

The kW Psychrometric Functions and PSYCH spreadsheet template were created by Jim Kelsey of kW Engineering.

**Refer first to the FAQs section for technical questions.** If you have already tried that and you need more help, or have other technical questions send them to:

**[psych@kw-engineering.com](mailto:psych@kw-engineering.com).**

## Copyright Notice

**Copyright 2016 kW Engineering.** All Rights Reserved.

The accompanying spreadsheet templates (PSYCH.XLT & PSYCH\_SI.XLT) and the visual basic modules (PSYCH.XLA) are provided free of charge. By using the software you agree to indemnify kW Engineering from any liability that might arise from its use.

Selling the code for this spreadsheet without prior written consent is expressly forbidden.

Obtain written permission from kW Engineering before redistributing this software over the Internet or in any other medium. In all cases this copyright header must remain intact.