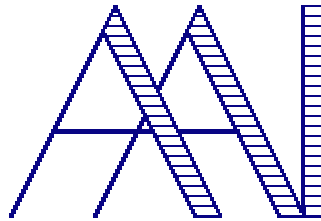# The Akton Psychrometric Chart
For Windows

User's Manual

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Chapter 1: Introduction

Getting Started

Minimum System Requirements:
Version 4 is a true 32bit Windows application. It can be run on any computer that is running Microsoft Windows 95, 98, Windows NT 4, or a later version of these operating systems. Performance may be unacceptable for some applications of this software on slower machines.

Recommended System Requirements:
In addition to the requirements above: A 133 Mz Pentium class computer with, 24Mb RAM, and 20Mb free hard disk space. More RAM may be required in order to integrate this package with other software products effectively.

Examples:
There are a series of examples in the later portion of this manual. Working through the examples should help familiarize you with the basic features of the program.

Notes On Use:
We believe that in keeping with good engineering practices an engineer will always ask the following questions when using a piece of engineering software.

1. Is the answer reasonable? Does the answer make sense in the context of your experience as an engineer with systems or processes that are similar?

2. Is the answer consistent? Does the answer make sense in the context of the rest of a project or process?

3. Last but not least! Is the answer verifiable? Can the answer be verified against other sources of information?

With that in mind we suggest that you take some time to run through some of the examples in this manual to familiarize yourself with the program, and verify that it meets the needs of your particular application.

Installation

Run the setup from the first distribution diskette. Alternatively if you have the CD distribution you can invoke the setup program from the autoplay program in the root directory of the disk. Normally this program starts automatically when the CD is inserted into the drive. To avoid possible conflicts it is a good idea to close any running applications, including screen savers before running the setup program. The setup program will prompt for installation locations and options. If you are not familiar with the program it is a good idea to go with default values for the options provided.

You must run the setup program. You can not just copy the files. The setup program will copy files to appropriate locations on your hard drive. It will also make a series of entries in the registry, and it will optionally add items to your start menu. In the event that you decide to remove the software from a computer it is recommended that you run the un-install program by using the "Add/Remove Programs" icon from the Windows control panel. This will safely remove all program files, registry entries, and menu items from your computer. If you move program files manually or make manual registry entries, it is possible that the program and the un-install program will not function correctly. If you wish to move the program to another location you should refer to the following section on licensing.

In order to license a program copy on a Windows NT computer you must install the CrypKey NT driver.

Software Support
Program support is available by fax, mail, and through our World Wide Web site. Limited phone support is available as time permits. It is our policy to respond to all inquires of registered users. Please include your program serial number, or your customer support number with your inquiry.

Web: http://www.aktonassoc.com
Phone: (925) 688-0333
Fax: (925) 685-0596
Write: Akton Associates Inc.
         3600 Clayton Rd. Suite D
         Concord, CA 94521

Check our web site for upgrades and program patches.

Program Overview

The Akton Psychrometric Chart for windows is a powerful calculation tool that can be used to perform energy and material balances for a large variety of engineering problems that involve mixtures of air and water.

The software has been left open ended as to temperature limits and pressure settings and has a very high upper limit for the humidity ratio. This does not mean that satisfactory results can be obtained over the entire range at which the chart will function. The PFL (Psychrometric Function Library) has also been left open to the user so that the constants can be changed and the software used for other binary systems of gases and vapors other than air and water. The following comments are in reference to specific limits of various parameters.

Pressure: The software will generate charts from very low pressures (a chart at 0.05 mm Hg) to very high pressures, potentially to the critical point of water (22 MPa, 3191 psia). Because the software makes use of ideal gas lows and water vapor does not always behave as an ideal gas, there can be significant error depending upon the pressure and temperature selected. For water vapor, the error grows larger as the pressure increases. At normal atmospheric pressure ranges, error will normally be less than 1% with normal ranges of water content.

Temperature: The chart can function at temperatures from minus 120 degrees F to upper temperatures in the thousands. The constants used in the PFL are adequate for 1800 degrees K or about 2500 degrees F.

Humidity Ratio: The software will function to a level of 1 lb/lb dry air, well beyond the level of most published charts.

We remind the user that the software will go beyond the normal limits of psychrometric charts and they should be aware of the possibility of significant error when using higher pressures, very high temperatures and large quantity of water vapor.
Be aware that the property that is presented as Wet Bulb Temperature is the thermodynamic wet bulb temperature, or temperature of adiabatic saturation. This differs slightly from the wet bulb temperature as measured with a sling psychrometer. If your applications requires more accuracy, then you should try to define points on the chart using other properties whenever possible.

It is possible to generate impossible points that lay above the saturation curve. And it is possible to extend the chart into pressures and temperatures that are beyond the applicable range of the PFL calculations. The primary reason for this is to provide a numerical convergence routine with continuous functions when solving for different sets of properties. A second reason is that the resultant line is sometimes of use when trying to solve problems graphically. And the third reason is to provide for the theoretically possible application of the PFL to systems that are not strictly air and water.

Licensing

Overview

Akton software licensing has changed. Akton now employs an encryption unlocking mechanism to manage its software licenses. We have incorporated a product from Kenonic Controls called Crypkey. There are some minor additional tasks to perform when installing this software. There are also significant benefits to Akton and our users. Our software can now be distributed easily over the internet, there by eliminating shipping costs. There is concurrent network sharing and license management for education and corporate environments. We have a more flexible licensing mechanism that allows us to create a larger number of licensing options.

All the code we distribute is the same, by default it installs as an Unlicensed copy and operates at level 0. Code can be distributed via diskette, CD, intranet, internet. Licenses are enabled by entering a "site key" which "unlocks the program." The key is based upon a "site code" that is generated when the software package is installed. The customer supplies the "site code", we supply the "site key." Once the program is "un-locked" it will function at the applied license level, and with the enabled license options

There are 3 license levels:
Level 0: Unlicensed, program functions in a demonstration mode with pressure permanently set 70kPa (approximately 10,000 feet elevation). This is the default when the program is first installed.

Level 1: Educational, pressure is permanently set 101.325 kPa (normal pressure at sea level). Education licenses are available to education institutions, and students with a valid student ID.

Level 2: Fully licensed, with no restrictions on what pressures the program can be run at.

Licenses can be "fixed" or allowed to "float"
Fixed licenses are single user licenses and the program can only be run on the licensed computer. Floating licenses are network licenses and can be run on any properly configured station on a network, but the total number of licenses can not be exceeded.

License Management

Below is the license management dialog that can be invoked from the tool->license menu pick on the main menu of the chart program.
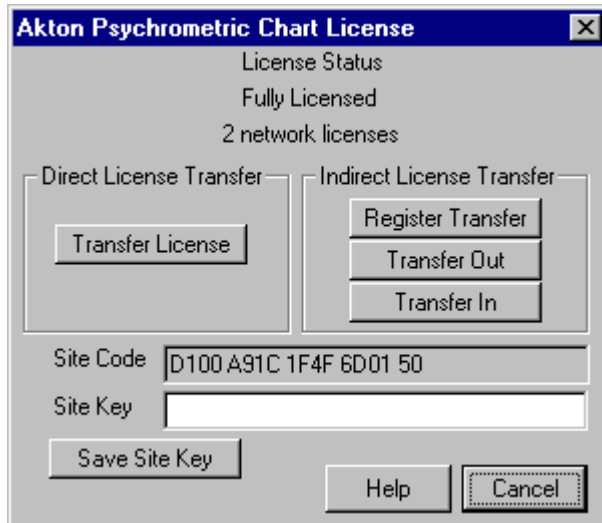
Site Code
The site code is an encrypted identifier for a particular site. This is the code the customer gives to Akton in order to get a site key. The site key combined with the site code "unlock" the program. After a valid site Key is entered a new site code is generated, and can be used to add additional license features, or to increase the count for a floating license.

Site Key
The site key is the encrypted code that when combined with the site code will unlock the program. Any given site key will only work for one particular site code. After a valid site Key is entered a new site code is generated, and can be used to add additional license features, or to increase the count for a floating license.

Direct License Transfer
The license can be moved, but not copied. To move a license using direct transfer first install the program in the new location as an unlicensed demonstration copy, and then transfer a license directly. Click on the "Transfer License" button inside the license management dialog of the licensed copy. You will be prompted for a directory. Provide the location of the newly installed unlicensed copy.

Direct Transfer will only work for directories on the same computer, or on directories on different computers that are both configured for network licensing.

Indirect License Transfer
The license can be moved, but not copied. To move a license indirectly first install the program in the new location as an unlicensed demonstration copy, and then transfer a license indirectly following these steps.

1. Register a transfer location from an unlicensed copy. Click on the "Register Transfer" button inside the license management dialog of the unlicensed copy. You will then be prompted to provide a directory. This directory can be any directory that both computers have access to, or a floppy disk.

2. Transfer a license out from the licensed copy to the registered transfer location. Click on the "Transfer Out" button from inside the license management dialog of the licensed copy. You will be prompted to provide a directory. Provide the same location you did in the previous step.

3. Transfer a license in to an unlicensed copy from the registered transfer location. Click on the "Transfer In" button from inside the license management dialog of the unlicensed copy. You will be prompted to provide a directory. Provide the same location you did in the previous step.

The license should now take effect inside the newly installed copy.

Moving your license
The licenses can be moved, but not copied. If you wish to move the program to another location, on a different computer, or even on the same computer. First install the program at the new location. Then transfer the license to the newly installed location from the existing location.

New location on the same computer:
1. First Copy the program files to the new location. The only file that actually needs to be copied is the akpsych.dat file, but you will need to copy the other files if you don't want to loose any customizations that you may have made.
2. Then transfer the license to the new location using the direct transfer method. Invoke the license manager from the main menu of the chart program and use the direct transfer option to directly transfer the license to the new location.
3. Then uninstall the program. Run the uninstall program to remove the previously installed copy from your computer.
It is also possible to just delete the program directory and its sub-directories. This will not remove registry entries, or start menu picks, but they will just be over written when you reinstall the program any way.
4. Then reinstall the program at the new location. Run the setup from disk one and install the program at the new location. If you have made any modifications to files, and copied them there, they will not be over written by the older files on the distribution diskettes.

New location on a different computer:
First install the program at the new location. Then transfer the license to the newly installed location from the existing location. After you have transferred the license you can delete the files or run the un-install program.

Network Licenses

The licensing scheme provides a mechanism for floating network licensing. In this case a floating license must be purchased from Akton, and a specified number of computers will be able to run the software concurrently from a network server. After the successful setup of a floating license any of the configured computers on the network will be able to run the software, limited only by the number of concurrent sessions being less than the number of floating licenses.

1. Floating network licensing requires that the server computer be configured with a license serving program.

Windows NT:
In the case of Windows NT this is the same driver that is already required to run the program and there are no additional requirements.

Novell:
Novell servers must run a NLM named CKSERVER.NLM it is provided with the base install and is located in the installation directory. The administrator of your Novell Network should copy this file to the system directory of the server that is going to serve the program, and load the NLM. CKSERVER.NLM is self-configuring, it will list itself in the startup.ncf for automatic startup if the server is rebooted. It does require Patch level 5 on 3.X Novell servers. No patches are required for Novell 4 servers or later.

Windows 95,98:
If you need to share the program on a network from a Windows 95,98 computer, you must run a CrypKey network driver wckserve.exe .   You must specify the directory of the program to be shared when the driver is loaded. This can be done either on the command line when the driver is loaded or in an environmental variable before the program is loaded.

examples:
wckserve.exe C:\progra~1\akton (command line)
SET ckserve=C:\progra~1\akton (setting an environmental variable)
these actions can be done in a batch file including autoexec.bat

2. Install the Akton software on the server.
Run the setup program from one of the stations that is going to run the program. In the case of a Windows 9x or NT server this may be the server itself, however if the server it not going to be used to run the software in practice it is still recommended to run the setup program from a different computer. When the setup program prompts for a installation directory change it from the default location (C:\Program Files\Akton) to a shared directory on your server. This should be a shared directory on the server that all the users, that are going to use the program have read and write rights in.

3. Start the program and use the license manager to obtain your site code. Contact Akton with your site code and obtain the site key. Install the license the same as with a single user copy. This step can be repeated multiple times to "bump up" the floating license count if more licenses are required later. Note: the site code will change every time you install a new site key.

4. Run the setup program at each of the stations that are going to run the software. This will create the necessary registry entries, to run the program. It will also place menu items on the start menu. In each of these installations you should substitute the shared network directory when an installation directory is prompted for. The setup program will not overwrite files that have a newer or equal date of creation. To facilitate ease, it may be desirable to run the setup program from a shared network drive. In this case copy the installation diskettes to the network in directories like:

NetworkDIr\APC41\Disk1
NetworkDir\APC41\Disk2
NetworkDir\APC41\Disk3

Then run the setup.exe program from the disk1 directory

5. Optionally the license can be locked to prevent users from moving/removing the license. See Locking the License


Locking The License

In certain situations it may be desirable for the administrator of the program to deny users the ability to transfer licenses. In a commercial or education network environment if a user can transfer out one or more licenses then that would provide a means for the theft of a license. In order to prevent this possibility there is a simple mechanism to lock out the license manager from transferring licenses.   If the system administrator creates a file named LOCK.LIC in the installation directory (must be in the same directory as akpsych.dat) then when the license manager is invoked it will be in read only mode. The contents of the file do not matter only its presence is required. This file should then have its attributes changed to prevent users from tampering with it.

NT License Driver

In order to obtain a site code and license the software on a Windows NT computer, a driver must be installed to server the license. The NT driver is available on our web site and is provided on the Distribution CD. If you install the driver using the autoplay program on the CD the driver will detect the APC software and be automatically configured. If you install the driver manually, or move the software from one directory to another you may need to configure the driver to serve the license.

This essentially means telling the driver what directory the APC software is installed in. After installing the NT driver a program is placed in you winnt directory, ckconfig.exe. Execute this program and the following dialog will appear.
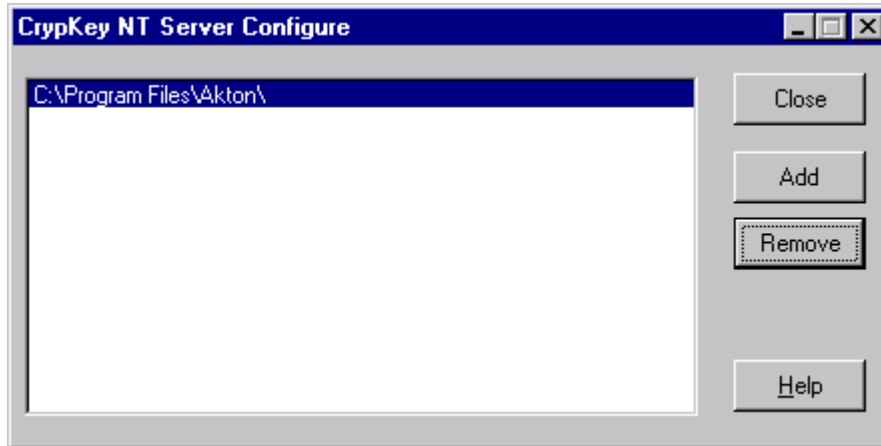
You can add and remove directories that are to have crypkey licenses served. You will need to add the directory into which the APC software has been installed. If you installed the software in the default location provided by the setup program this will be: "C:\Program Files\Akton" If you click the add button the file your are looking for is akpsych.dat.

The NT driver is only required on the computer on which the software resides. In the case of a floating network license, only the NT server requires the driver, not NT workstations running the software remotely.

Chapter 2: User Basics

Introduction

The user interacts with many program elements, or objects through the use of the mouse. There are three program windows: The <u>chart window</u>, the <u>properties window</u> and <u>the report window</u>. All three of these windows are user interactive, with the objects presented in them responding to one or more of the following mouse commands.

The **left mouse button click** is in general used to *create or activate* an object. For example: If you left click on empty space in the <u>properties window</u>, you will be prompted to select a new property to add to the current property set.

The **right mouse button click** is in general used to *edit or modify* an existing object. For example: If you right click on an existing property in the <u>properties window</u>, you will invoke a dialog box which will permit you to edit the attributes of the property you clicked on.

The **left mouse button double click** is in general used to *select* an object. For example: If you double click on a property in the <u>properties window</u> while the edit point dialog box is open, that property will become one of the defining properties for the point being edited.

The **left mouse button drag** is in general used to *move, reposition* an object or select a region. For example: Properties in the <u>properties window</u> can be repositioned by dragging them to a new location with the left mouse button.

By knowing the general actions associated with the different mouse commands, it is possible to learn the basics of the program through experimentation. You can try different mouse commands on objects, and they will either respond, or they wont. There is no harm in experimenting. The following sections individually cover the three windows, and describe precisely how they are user interactive.
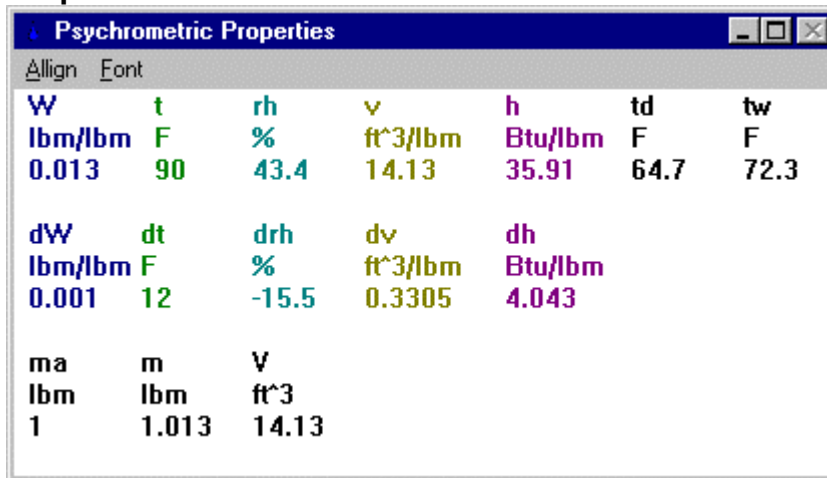
Chart Window
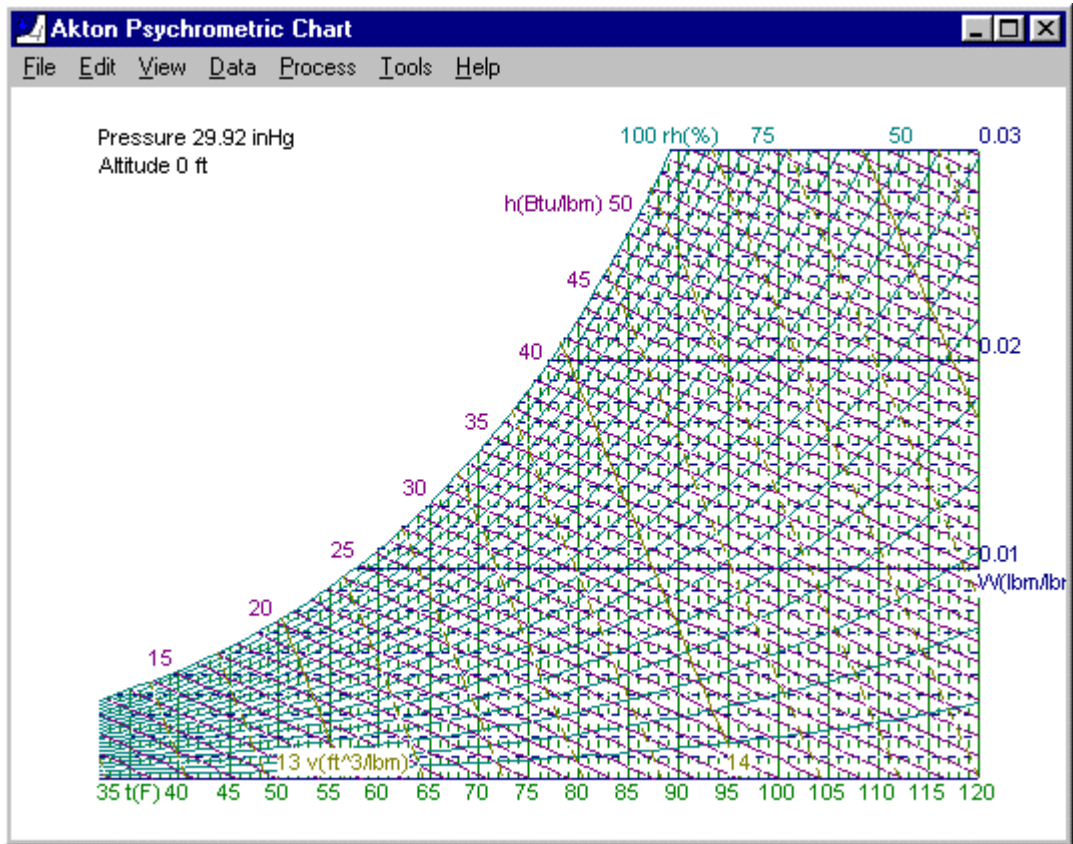
The "chart window" is used to display the current chart. It is always present while the program is running. It serves as the main window, and the other windows are child windows of the "chart window". The chart window is closely tied to the "properties window", and as the cursor is moved over the chart, the property values are updated in the "properties window" to reflect the current position of the cursor.

Points may be *created* on the chart by clicking on the chart with the **left mouse button**. Existing points on the chart may be *edited* by clicking on or close to the existing point with the **right mouse button**. These actions will cause the "Create Point" or "Edit Point" dialog box to appear.

Areas of the chart may be "zoomed in on" by first selecting the zoom option from the view menu (this will change the mouse cursor to a magnifying glass) and then left mouse button dragging over a region of the chart.

Properties Window

The properties window is a fundamental part of the program. It is always present while the program is running. Because it provides many essential features used in relations with other windows, it can not be closed, it can only be minimized. The properties window displays the current set of thermodynamic properties the user has selected.

Normally the values indicate either the current, or last valid position of the cross hair cursor over the chart. If the edit or create point dialog box has been invoked, then the values correspond to the point as defined in the edit or create point dialog box.
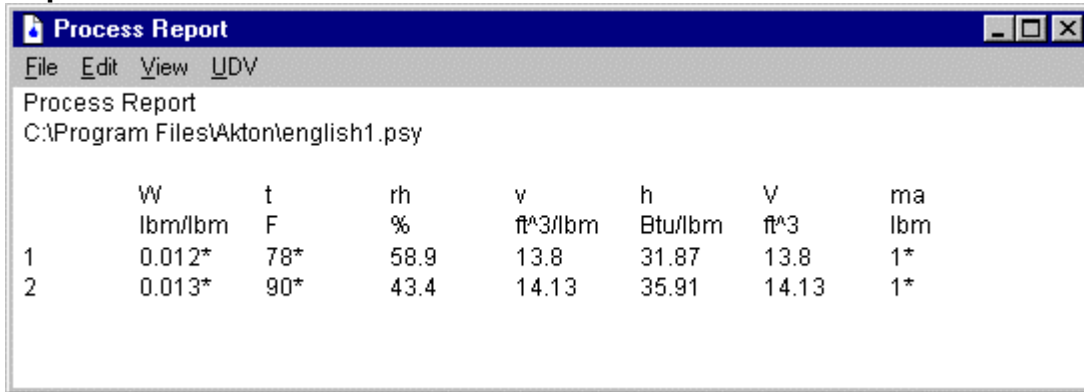
Properties can be added to the properties window by clicking on a blank portion of the window with the **left mouse button**. A list of available properties will be presented, select one and it will appear in the properties window at the position of the mouse click.

The attributes of a property may be edited by clicking on the property with the **right mouse button.** This causes the "Psychrometric Property" dialog box to appear. Here the user may alter the descriptions, units, significant figures and other attributes for each thermodynamic property. A property may be removed from the properties window by clicking the delete button in this dialog box.

Properties may be rearranged by dragging the property with the **left mouse button**. Place the mouse cursor over a property then click and hold the mouse button in order to drag it to another location in the window.

The properties window also interacts with the create or edit point dialog box. Properties and values are selected to the create or edit point dialog box by **double clicking** on the desired property with the **left mouse button**.

Report Window

```
Process Report                                    _ □ ×
File  Edit  View  UDV
Process Report
C:\Program Files\Akton\english1.psy

         W         t       rh      v        h        V        ma
         lbm/lbm   F       %       ft^3/lbm Btu/lbm  ft^3     lbm
1        0.012*    78*     58.9    13.8     31.87    13.8     1*
2        0.013*    90*     43.4    14.13    35.91    14.13    1*
```

The report window is an optional window that can be invoked from the process report option of the data menu. While the report window is present it displays a user selected set of properties for each point that is currently defined on the chart. In the report window, properties that define the point are immediately followed by an asterix. While it is present, the report window also provides an alternative way to edit points, and properties.

A point may be selected for *editing* by clicking on the row of the point with the **right mouse button**. This has the same effect as clicking near a point in the chart window with the right mouse button. This is an especially valuable feature when more than one point occupies the same conditions, or when a point has been defined that is out of the range of the chart.

A property may be *edited* by clicking on the column header (symbol or units of the property) in the report window with the **right mouse button**. This has the same effect as right clicking on a property in the properties window.

A new property may be *added* to the report by clicking on empty space at the top of the report with the **left mouse button**. Properties must by available in the properties window in order to appear in the report window.

The order of properties can be altered by clicking on the column header with the **left mouse button**. This causes a property to exchange places with the property on its immediate right.

A newly added feature of the report window allows point to point differences to be displayed for any delta property between any two points. This can be accomplished by clicking on the row of a point with **left mouse button**. This prompts the user for a point to link to, and displays the differences at the bottom of the report.

Once a link has been established it can be deleted by clicking on the link row with the **right mouse button**. It is currently a program feature/flaw that links are not stored in the chart file (chartname.psy), and have to be created each time the chart is recalled.

The user has control of the tab spacing and font, through the view menu inside the report window. The edit menu provides for copying the report to the windows clipboard, and the file menu provides for printing the report.

While the report window is on the screen the program maintains the report to reflect the current state of any process that is defined or being edited on the chart.

Creating and Editing Points

The <u>create / edit point dialog box</u> is a very important element when working with the program. It can be invoked in a variety of ways, to either create new points, or edit existing points on the chart.

This dialog box interacts with the <u>properties window</u>. While this dialog box is present, the values of the properties in the <u>properties window</u> reflect the current point being created / edited in this dialog. Properties can be selected or sent to this dialog box by double clicking on them in the properties window with the left mouse button. Alternatively properties can be selected using the drop lists.

Pressure Property Box
The first property box displays the current pressure defining property. It is for information only. At this time the program does not support analysis of processes with a change in pressure. The pressure is set for the chart, and all points on the chart through the "Chart Options" dialog box.

Specific Property Boxes
The second and third property boxes are used to indicate the two specific properties and their values as used to define the point on the chart. The user may transfer properties to the "Create / Edit Point" dialog box, by double clicking on them in the psychrometric properties window. If a redundant property is selected it will replace the redundancy. If it is not a redundant property, it will replace the property indicated by the radio buttons on the left edge of the dialog box. The radio button will automatically progress to the next property box when appropriate.

Alternatively properties can be selected using the drop list. Not all the available properties may appear in the drop list. If a property is synonymous with one of the currently selected properties, it will appear only in that property's drop list.

Mass Property Box

The fourth and last property box is the mass defining property. It is only relevant to start and entry points. The user may select any of the mass defining properties from the psychrometric properties window to this property box by double clicking on the one of the mass defining properties in the properties window.

Alternatively properties can be selected using the drop list. Not all the available properties may appear in the drop list. If a property is synonymous with one of the currently selected properties, it will appear only in that property's drop list.

Specific Property Radio Buttons

If a redundant property (a property that translates directly to an existing one) is being selected it will replace the redundancy.   Otherwise it will replace the property with the radio button checked next to it.

Point Type Radio Buttons

The point type radio buttons are used to indicate the type of point that is or is to be defined. While creating or editing a point, some types may be disabled depending on the definition of the previous points. For example the first point on the chart must always be an entry point.

OK Button

The "OK" button will; calculate the point, add the point to the chart, and close the dialog box. A common mistake is to click on the "Add Point" button and then to click on the "OK" button, defining two points when only one is desired.

Cancel Button

When editing a point, use the cancel button to restore the current point to its original state, and close the dialog box. When creating a new point the cancel button will close the dialog box without adding a new point.

Calculate Button

The calculate button can be used to evaluate a point as it is currently defined without closing the dialog box. If the evaluation fails an error message will be given. If it is a success, all of the other windows will be updated to reflect the current definition.

Delete Button

The delete button can be used to delete a point.   Because of how the calculation model is developed it is only possible to delete the last point. This button is disabled when creating points and when it is not the last point being edited.

Advanced

The advanced button invokes a dialog box that enables the user to configure how the mass property is calculated from preceding points. It is only relevant to process points, and mix points. By default these points inherit their mass from the preceding point.

Add Point Button

The add point button will attempt to add the new point with out closing the dialog box. It is the equivalent of clicking the "OK" button and then clicking on the exact same spot on the chart. This can be helpful when adding multiple points, because it allows the user to hold any property constant between successive points. This button is disabled when editing existing points.

Text Align

Use the text align radio buttons to indicate how the point description should be aligned around the point. When looking at the set of four radio buttons, consider the point to be in the middle.

Color

The color for an individual point can be selected by clicking on the "color" button inside the create / edit point dialog box. By default points inherit their color from the setting selected for pen color on the global chart options property page, which can be invoked using the chart options pick under the view menu of the main chart window.

Font

The font for an individual point can be selected by clicking on the "font" button inside the create / edit point dialog box. By default points inherit their font from the setting selected for pen font on the global chart options property page, which can be invoked using the chart options pick under the view menu of the main chart window.

Description

A point description may be entered. It will appear on the chart next to the point. Font color and size are set through the use of the Pen Options dialog box.

The File Menu

File New

This pick creates a new chart.   When a new file is created the name is cleared, so that no file name appears in the title bar of the main window.   A file named default.psy is placed in a sub folder of the installation directory selected by the user at the time of installation. A different default chart can be selected, by altering the program user preferences, from the main edit menu. If the default file is missing or damaged then the program will generate a new file using program defaults for all values. The built in program defaults are always metric, and can not be altered by the user.

If no file name has been assigned (as normally appears in the title bar of the main window) you will be prompted for one when you try to save the chart, or exit the program.

File Open

This pick prompts you to choose an existing chart file to open. By default, chart files are saved with an extension of ".PSY". If there are any changes to the currently open chart you will be prompted to save your changes.

Version 4 has the capability to read version 3 files, however it can only write version 4 files. If you attempt to open a version 3 file you will be warned that if you save the file it will be converted to a version 4 file. If you have made any changes to the PFL configuration under version 3 you may need to make them again after the conversion. Version 4 cannot necessarily determine if the PFL configuration was left to defaults or is missing or damaged.

File Save

This pick saves any changes to the current chart under the current file name. If no file name has been assigned (as normally appears in the title bar of the main window) you will be prompted for one.

File Save As

This pick prompts for a new name to save the current chart by. If you pick an existing file name, it will be overwritten. By default files are created with the extension of ".PSY" unless another extension is given. This will cause the chart to be recalculated, and if there is an existing file for the previously current chart, it will remain unchanged.

File Print

The File Print pick prints the chart. The user is first presented with the Windows Common Print Dialog Box, in which the printer may be selected and configured.

Notes on Printing:

Some printers and most fax software will not print colors other than black because their drivers interpret all colors not black as white. If you find lines and figures disappearing from your charts when printing or faxing, try changing all colors to black, or consult your printer or fax software documentation.

Many attributes of how the printout appears can be altered through configuration options. Of particular interest in many cases is the chart resolution setting.

File Exit

The File Exit pick terminates the program. If any changes have been made to the currently open chart, you will be prompted to save before program termination.

The Edit Menu
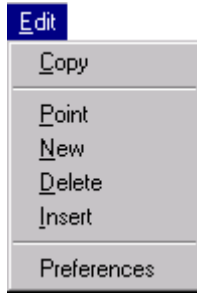
Edit Copy
The Edit Copy pick copies the current chart picture to the Windows clipboard, where it can then be copied to other windows programs. The image is transferred in the form of a Windows metafile, and can be pasted into any windows program that supports metafile pictures on the clipboard.

Edit Point
After selecting the edit point menu item, a dialog box will appear presenting a list of all the currently defined points. Select the point you wish to edit, and the edit dialog will open with the point you selected. The menu item does nothing if there are no points defined.

Edit New
After selecting the edit new menu item the "Create Point" dialog box will open so that a new point can be defined on the chart.

Edit Delete
After selecting the edit delete menu item, a dialog box will appear presenting a list of all the currently defined points. Select the point you wish to delete, and the program will attempt to delete that point. Only points that are not referenced by other points in the current model can be deleted, all others will return an error message.

Edit Insert
After selecting the edit insert menu item, a dialog box will appear presenting a list of all the currently defined points. Select the point you wish to insert a new point in front of, and a new point will be inserted into the position directly in front of the point you selected. The edit point dialog will then open with the newly inserted point so that you may edit its definition.

Edit Preferences
Opens a dialog box that permits program preferences to be configured. Program preferences are saved in the Window's registry under the current user key. Different preferences can be saved for each user on a multi user system
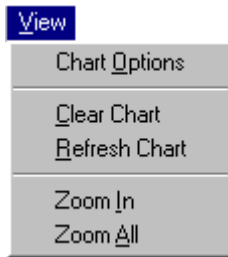
The View Menu

Chart Options
This menu pick invokes the "Chart Options" dialog box. Many attributes of how the chart is calculated and presented on the screen may be accessed through this dialog box. See "Chapter 3: Customizing the Chart."

Clear Chart
This menu pick clears the chart. All points are deleted from the current chart, and the chart image is refreshed on the screen.

Refresh Chart
This completely refreshes the chart, recalculating the chart, and all of the points, and then refreshing the image on the screen.

Zoom In
This menu pick invokes the zoom mode.   To zoom in on a region of the chart: First select the *zoom in* option from the *view* menu. This will cause the cursor over the chart window to become the shape of a magnifying glass. Next, place the cursor over one of the corners of the region to zoom in on. Now, click and hold the left mouse button while dragging the cursor to the opposite corner of the region. A color inverted box should appear on the chart while you are selecting the region.

Beware of trying to zoom in on too small an area. It is possible to zoom in on an area so small that the window extents are too large for the Windows GDI, and a fatal error will occur. Note also that it is possible to severely distort the chart by zooming in on a rectangle with a poor aspect ratio. You can zoom in multiple times.

Zoom All
The Zoom All menu pick returns the chart to normal appearance from the zoomed in state. It has no effect on a chart that has not been zoomed in.

The Data Menu
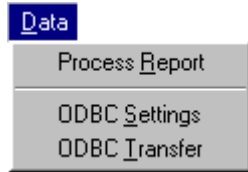
Process Report

This menu pick will create a simple process report. The report will appear in the report window. There it can be configured, and printed. The properties that appear in the report are selected through the use of the Psychrometric Property dialog box.
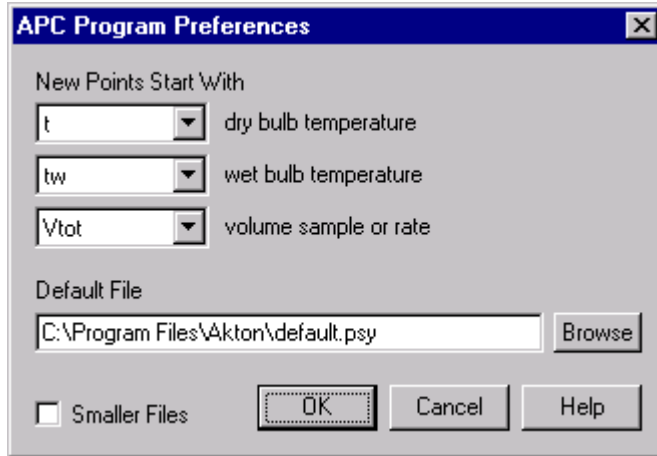
ODBC Settings

Invokes ODBC Settings dialog box. See chapter 6

ODBC Transfer

Invokes an attempt to transfer report data using the ODBC connection.

Program Preferences

Program preferences are saved in the Window's registry under the current user key. Different preferences can be saved for each user on a multi user system

Default Properties
The default properties are the properties that will appear initially in the "Creating Point" dialog box when new points are created on the chart.

Default File
The default file is used as a template user creates a new file from the file menu. Any "psy" file created with Akton's Psychrometric Chart program can be used as the default file. Whenever a user selects File/New from the main menu the default file is loaded with no title. If the default file is unavailable or missing, program base defaults will be used instead.

Smaller Files
The smaller files option removes the graphical image from psy files when they are saved. This makes them considerably smaller, however the entire chart has to be recalculated whenever the file is opened. Using the smaller files option is recommended for people who wish to share their files over a modem connection. It is not recommended for people who have slower computers.

Chapter 3: Customizing the Chart

Introduction

Charts can be customized in a number of ways. The limits or boundaries of the chart may be altered. The appearance of the chart may also be modified.

There are five properties that can be displayed on a chart. Each property has a variety of attributes that can be set or selected. The applicable attributes for each property can be displayed or altered by bringing its page to the foreground and editing its attributes.

The chart is generated, stored, printed and transferred to the clipboard in the form of a windows metafile. A Windows metafile is a series of graphical vector instructions that are intended to be used by the windows GDI (graphical device interface). We have tried to give as much control as possible to the user. An understanding of the Windows GDI may helpful in understanding some of the options, but is not a requirement to use the program.

Global Chart Options
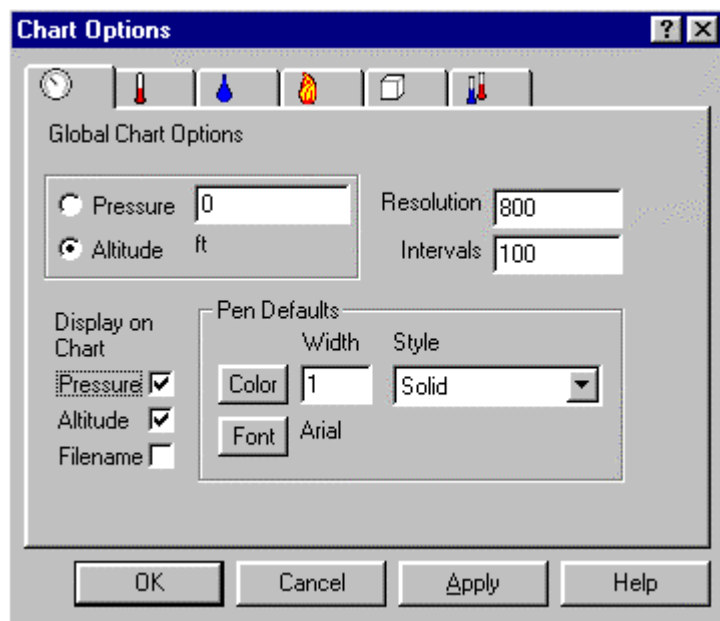
Pressure Radio Button
Indicates that the chart is to be calculated at a given pressure. The pressure is entered in the accompanying edit box. The currently selected units for barometric pressure are displayed below the edit box.

Altitude Radio Button
Indicates that altitude is to be the pressure defining property, that the chart is to be calculated at a given altitude. The altitude is entered in the edit box below. The currently selected units for altitude are displayed at the right of the edit box. Altitude is actually converted to barometric pressure during calculations.

Resolution

Resolution refers to the number of logical units on an axis of the chart. This number refers to both horizontal and vertical axes. It effects the thickness of lines on the chart, the size of fonts, and the ability to zoom in on the chart. Excessively high values cause deterioration of program performance and GDI errors. Excessively low values cause poor looking (chunky) charts, can cause the screen to blank out in a single color, and also can cause GDI errors. What is excessively high or low may vary among different hardware with different hardware drivers, or capabilities. The default value is 800.

Intervals

Intervals refers to the number of discrete segments to calculate when plotting a property on the chart. It effects the smoothness of curves and the size of the metafile image. Low values cause lines to appear jagged. High values can cause sever performance deterioration and GDI errors. By default the value is 100.

Pressure Check Box

Use the pressure check box if you desire the barometric pressure for the chart to be displayed in the upper left hand corner of the chart.

Altitude Check Box

Use the altitude check box if you desire the altitude (elevation) to be displayed in the upper left hand corner of the chart.

Filename Check Box

Use the filename check box if you desire the file name of the current chart to be displayed in the upper left hand corner of the chart.

Default Pen Color

The pen color refers to the color that will be used when process points, lines, and labels are written to the chart. This button invokes the standard windows select color common dialog box.

Default Pen Font

The pen font refers to the font that will be used for point descriptions when written to the chart. This button will invoke the standard windows select font common dialog box where the font face and font size may be selected.

Default Pen Width

Pen width refers to the width of the lines to be drawn on the chart. Values greater than one refer to the width in logical units. Logical units are defined by the resolution parameter. A value of zero translates to one device unit (pixel).

Default Pen Style

Use the pen style drop box to select from the standard window's GDI pen styles for process lines.

Property Options
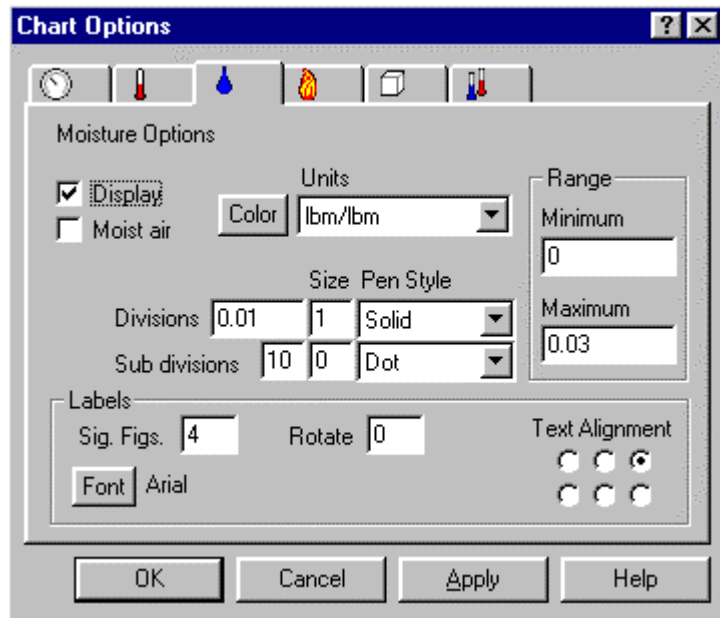
Display Check Box
The display check box indicates whether the current property is to be plotted on the chart or not. Check this box if you would like the current property to be plotted on the chart.

Moist Air Check Box
The moist air check box indicates whether the current property is to be plotted on a moist air basis. Check this box if you would like the current property to be plotted on a moist air basis. The check box is disabled if it is inapplicable to the current property. Relative humidity, and dry bulb temperature can not be on a moist air basis.

The moist air counterpart for humidity ratio is specific humidity.

Assume Linear Check Box
The assume linear check box can be selected for specific enthalpy and specific volume. It is disabled for the other properties. If this option is selected, the program draws a single straight line when plotting the currently selected property. This can significantly reduce the size of the metafile and make for much faster screen refresh on slower systems. It can also make it easier to work with the image when copying the image to other software.

Depending on the range selected for the chart, significant error can result in the chart image from making this assumption.

Color Button
Use the color button to invoke the Window's color selection common dialog box. This way you may select the color you wish for the currently selected property.

When selecting colors other than black it is important to keep in mind that some printers and most fax software treat all colors other than black as white.

Units List Box

Use the units list box to select the units for the currently selected property. Click on the down arrow at the right of the list box and a list of available units will be displayed. If the units you desire are not available, it is possible to add new unit definitions through the use of the unit configuration utility under the tools pick of the main menu.

The units selected here only effect the plotting of the chart, they do not effect the units selected for the properties in the "properties window" or the units displayed on reports.

Divisions

Divisions refers to the distance between labeled lines on the chart. The program expects a real (floating point) number, representing the distance between lines that are to be labeled on the chart. The value should be in the units selected.

Sub Divisions

Sub divisions refers to the number of unlabeled lines that are to appear between the labeled lines on the chart. The program expects this to be an integer value. A value of zero will cause subdivisions to be omitted.

Pen Size

Pen size refers to the width of the lines to be drawn on the chart. Values greater than zero refer to the width in logical units. Logical units are defined by the resolution parameter.   A value of zero translates to one device unit (pixel).

Pen Styles

Use the pen style drop box to select from the standard window's GDI pen styles for divisions and subdivisions.

Labels Font

Click on the labels font button to invoke the Window's font selection common dialog box. Use this to select the font face and size to be used for the labels of the currently selected property.

Labels Rotate

The labels may be rotated around the end point of a division line by entering an angle in this edit box. Angles are in degrees (0-360) going counter clockwise from 3 O'clock. Not all fonts support this capability, choose a true type font to explore this feature.

Labels Significant Figures

Enter the number of significant figures to use for the labels of the currently selected property. Significant figures refers to actual numerical significance, NOT decimal places.

Labels Text Alignment

Use the text alignment radio buttons to indicate how the label should be orientated around the end point of the divisions lines for the currently selected property. The label should be orientated as if the text were the selected radio button, and the end point was in the middle of the radio buttons.

Range Minimum

The range minimum is the low value for either the horizontal axis (temperature) or the vertical axis (moisture). It is disabled for the other properties.

Range Maximum

The range maximum is the high value for either the horizontal axis (temperature) or the vertical axis (moisture). It is disabled for the other properties.
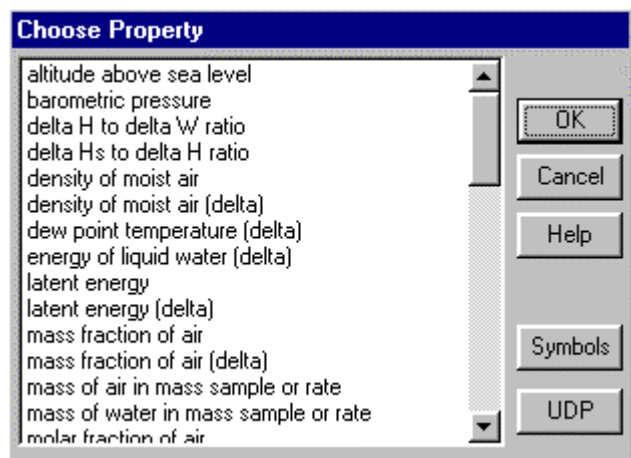
Chapter 4: Properties

Introduction

There are currently sixty six built in psychrometric properties from which to choose. The actual property definitions and calculations exist in the Akton Psychrometric Function Library (PFL). The calculations and definitions are described in the PFL reference section of the printed manual, or in the PFL help file (akpfl.hlp). It is unlikely that any given application will have need of all sixty six properties. To avoid confusion it is recommended that the user select a set of properties that are pertinent to their application, and customize them to suit the problem at hand. It is often helpful to arrange related properties together in the properties window and on reports. There is a complete list of the available properties and their definitions in the PFL documentation.

Akton's version 4 of the psychrometric chart supports user defined properties. User defined properties allow the user to define a custom property by providing an equation composed of the built in properties, scientific functions, the operators +,-,*,/ , and even preceding user defined properties.

Choose Property Dialog Box

The "Choose Property" dialog box appears when it is necessary for the user to select a property. Examples would be the addition of a new property to the properties window, or report window. When invoked, this dialog displays only properties that are allowable, and not already selected, for the purpose at hand.

Choose Property

```
altitude above sea level
barometric pressure
delta H to delta W ratio
delta Hs to delta H ratio
density of moist air
density of moist air (delta)
dew point temperature (delta)
energy of liquid water (delta)
latent energy
latent energy (delta)
mass fraction of air
mass fraction of air (delta)
mass of air in mass sample or rate
mass of water in mass sample or rate
molar fraction of air
```

[OK]
[Cancel]
[Help]
[Symbols]
[UDP]

Select the property you wish to add by high lighting the property description and then clicking on the "OK" button. Alternatively just double click on the property you wish to select.

The user may toggle between the longer property descriptions, and the shorter property symbols by using the *Symbols / Descr*. toggle button at lower right hand corner of the dialog.

The UDP button can be used to begin the definition of a "User Defined Property."

Psychrometric Property Dialog Box

Use the "Psychrometric Property" Dialog box to edit or alter the various attributes that are assigned to a psychrometric property. This dialog box is accessed by clicking with the **right mouse button** either on a property in the properties window, or on a column header inside the report window. If you are viewing this file as a windows help file you may move the cursor over the image below and click for more information.
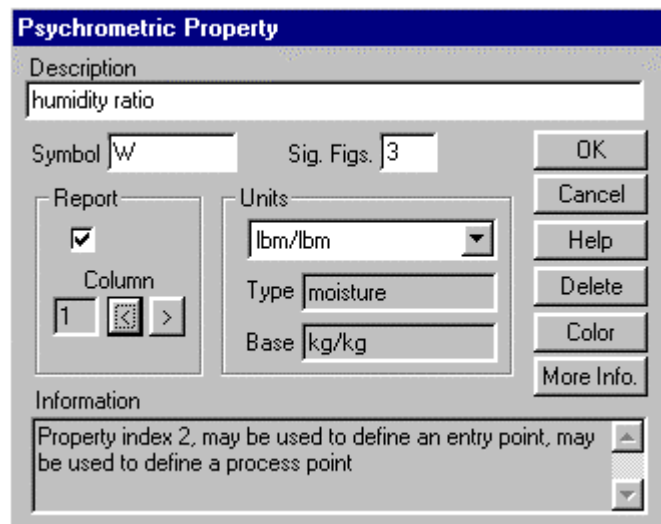
Description
Each property has a description of up to fifty characters in length. The description appears in the property boxes of the "Create/Edit Point" dialog box, and other places as well. The user may edit this description to be any thing they like. It may help to make property selection easier if the user is presented with terminology that they are familiar with.

Symbol
Each property has a symbol of up to eight characters. The symbol serves to designate a property with a shorter descriptor. By default many properties are given symbols that are meant to be consistent with ASHRAE conventions as presented in the ASHRAE Brochure on Psychrometry. Property symbols are used in many of the windows and dialogs to designate their respective properties. Property symbols are also used when referencing a property inside user defined equations.

A chosen symbol should be unique among all the symbols selected for built in properties, user defined properties, and user defined variables.

Care should be given when assigning symbols to properties. The symbols assigned here are used when indicating variables to be used with DDE connections, and they are also used as column names for the insert command in the ODBC database connection. Changing a symbol may cause established DDE and ODBC connections to stop working, requiring them to be modified in order to function properly again.

Significant Figures
Each property can be assigned a number of significant figures. Each property is rounded to its significant figures when presented in the properties window, and on reports. Significant figures refers to actual numerical significance, NOT decimal places; it effects only the presentation of property values, not the calculations.

Report

Click on the "report" check box to indicate that it is desired for the property to appear on process reports.

Report Column

The order of the properties on the process report can be modified by selecting the column that property is assigned to in the report box inside the "Psychrometric Property" dialog box. The column order can also be rearranged by clicking with the **left mouse button** on a column header inside the report window. This will cause a property to switch places with the property on it immediate right.

Units

Use this drop list to choose the units you wish to assign for the property. Upon exit from the dialog box, if the units have changed, you will be given the option to change the units for all properties of the same unit type.

Unit Type

Indicates the unit type for the property. This is the unit type as used with the unit conversion module for converting values among different units. This is informational only and can not be altered by the user.

Base Units

Indicates the base unit for the property. The base units are the units in which all calculations are carried out. Sometimes rounding errors can be avoided by working in the base units of a property. This is informational only and can not be altered by the user.

Delete

Use this option to remove the property from the "Psychrometric Properties" window, and reports.

Color

Use this option to choose or alter the color of the property as it appears in the "Psychrometric Properties" window.

More Info.

This button invokes the windows help system with the information on the property from the PFL help file. The help file will be opened and positioned to the property's definition topic.

Information

The information box gives some basic information regarding the current property, and how it can be used. Clicking on the "More Info." button invokes the windows help system with the property description from the PFL help file.

User Defined Properties

User defined properties provide a great deal of program flexibility. Users may define properties for a variety of reasons. The most obvious is to perform a calculation that is not built in or provided for by the program. Another reason is to present values for an existing property in more that one system of units at the same time.

After a UDP is defined. The user may interact with it in very much the same way as they would a built in property. There is one very note worthy exception: User defined properties can not be used in the definition of points on the chart.

Description
Each user defined property has a description of up to fifty characters in length. Users may edit this description to be any thing they like.

Symbol
Each user defined property has a symbol of up to eight characters. The symbol serves to designate a property with a shorter descriptor.   Property symbols are used in many of the windows and dialogs to designate their respective properties. Property symbols are also used when referencing a property inside user defined equations, or in a DDE connection.

A chosen symbol should be unique among all the symbols selected for built in properties, user defined properties, and user defined variables.

Care should be given when assigning symbols to properties. The symbols assigned here are used when indicating variables to be used with DDE connections, and they are also used as column names for the insert command in the ODBC database connection. Changing a symbol may cause established DDE and ODBC connections to stop working, requiring them to be modified in order to function properly again.

Significant Figures
Each user defined property can be assigned a number of significant figures. Each property is rounded to its significant figures when presented in the properties window, and on reports. Significant figures refers to actual numerical significance, NOT decimal places; it effects only the presentation of property values, not the calculations.

Report

Click on the "report" check box to indicate that it is desired for the user defined property to appear on process reports.

Report Column

The order of the properties on the process report can be modified by selecting the column that property is assigned to in the report box inside the "Psychrometric Property" dialog box. The column order can also be rearranged by clicking with the **left mouse button** on a column header inside the report window. This will cause a property to switch places with the property on its immediate right.

Units Type

Indicates the unit type for the user defined property. This is the unit type as used with the unit conversion module for converting values among different units. In the built in properties, this is informational only and can not be altered by the user. With user defined properties the unit type is selected by the user.

Units Base

Indicates the base units for the user defined property. In the case of a user defined property the base units indicate the units the user expects the equation to yield a value in. This value can then be converted to other units by selecting different output units. The results of the equation will be converted from these units to the output units before they appear in a window, are referenced in equations, or transferred in a DDE connection.

Units Output

Use this drop list to choose the units you wish to assign for the output of the property.   The value that appears on reports, or that is referenced in other equations, or is transferred in a DDE connection, is expected to be in the units selected here.

Delete

Use this option to completely delete a user defined property. All data associated with the user defined property will be removed from memory, and any user defined equations that reference the UDP will become invalid. Any DDE connections that reference the UDP will be terminated.

Color

Use this option to choose or alter the color of the property as it appears in the "Psychrometric Properties" window.

Equation

Enter the equation that defines your user defined property in the equation edit box.
UDP equations can be comprised of:

Operators
Functions
Properties

examples:

[t] - [td]
calculates the difference between dry bulb temperature and dew point temperature.

sin(([t]^2) * 2)
sine of t squared times two where t is the symbol for the dry bulb temperature property.

User Defined Variables

User defined variables provide a means to define calculations across multiple points. The results are displayed in the report window, and can be referenced in other UDVs or in a DDE connection.

Description
Each user defined variable has a description of up to fifty characters in length. The user may edit this description to be any thing they like.

Symbol
Each user defined variable has a symbol of up to eight characters. The symbol serves to designate a variable with a shorter descriptor.   Variable symbols are used in the windows and dialogs to designate their respective variables. Variable symbols are also used when referencing a variable inside user defined equations, or in a DDE connection.

A chosen symbol should be unique among all the symbols selected for built in properties, user defined properties, and user defined variables.

Care should be given when assigning symbols to variables. The symbols assigned here are used when indicating variables to be used with DDE connections, and they are also used as column names for the insert command in the ODBC database connection. Changing a symbol may cause established DDE and ODBC connections to stop working, requiring them to be modified in order to function properly again.

Significant Figures
Each user defined variable can be assigned a number of significant figures. Each variable is rounded to its significant figures when presented in the report window. Significant figures refers to actual numerical significance, NOT decimal places, it effects only the presentation of variable values, not the calculations.

Units Type
Indicates the unit type for the user defined variable. This is the unit type as used with the unit conversion module for converting values among different units. In the built in properties this is informational only and can not be altered by the user. With user defined variables the unit type is selected by the user.

Units Base

Indicates the base units for the user defined variable. In the case of a user defined variable the base units indicate the units the user expects their equation to yield a value in. This value can then be converted to other units by selecting different output units. The results of the equation will be converted from these units to the output units before they appear in a window, are referenced in equations, or transferred in a DDE connection.

Units Output

Use this drop list to choose the units you wish to assign for the output of the variable. The value that appears on reports, or that is referenced in other equations, or is transferred in a DDE connection, is expected to be in the units selected here.

Delete

Use this option to completely delete a user defined variable. All data associated with the user defined variable will be removed from memory, and any user defined equations that reference the UDV will become invalid. Any DDE connections that reference the UDV will be terminated.

Equation

Enter the equation that defines your user defined variable in the equation edit box.
UDV equations can be comprised of:

Operators
Functions
Properties
Variables

example:

[Pt1].[W] / [Pt2].[W]
Calculates the ratio of humidity ratio at "Pt1" to the humidity ratio at "Pt2", It could be expressed as a percentage.

User Defined Equations

Version 4 of the Akton Psychrometric Chart has a built in equation parser. It provides the program with the ability to evaluate mathematical equations. Users can use this capability to define further calculations for properties and variables. It is a relatively simple parser and relies on a simple context insensitive language. It supports a simple set of common operators, and a simple set of scientific functions. The values of various program variables can be substituted inside equations by referencing them with their symbols enclosed in brackets [].

Please note:
The (-) token is used as a binary operator to subtract one value or expression from another. If the left of the (-) operator evaluates to zero, then it acts the same as an a unary negation. To perform a unary negation of a value or expression the chs() function should be used to ensure more reliable equation evaluation.

It is advisable to use parentheses liberally when defining an equation to avoid possible ambiguities in the evaluation precedence of operators and functions.

Operators
The following operators can be used when defining equations.

+   add
-        subtract
*   multiply
/   divide
^   exponent
(begin expression
)   end expression

The (-) token is used as a binary operator to subtract one value or expression from another. If the left of the (-) operator evaluates to zero, then it acts the same as an a unary negation. To perform a unary negation of a value or expression the chs() function should be used to ensure more reliable equation evaluation.

It is advisable to use parentheses liberally when defining an equation to avoid possible ambiguities in the evaluation precedence of operators and functions.

Functions
The following functions can be used when defining equations.

chs()   unary negation
log()   log10
ln()   natural logarithm
abs()   absolute value
inv()   inverse
sin()   trigonometric sine
cos()   trigonometric cosine
tan()   trigonometric tangent

A valid expression must be inserted inside the parentheses immediately following the function identifier.

Properties
When property values are to be used inside an equation their symbol as defined for the property is to be placed inside brackets [], and then embedded in the equation. The brackets are reserved characters and can not be used in the property symbol directly. Previously defined user defined properties may be used in an equation the same as the 66 built in properties. It is important to note that if a user changes a property symbol, any dependent equations are not updated and become invalid.

For user defined variables (UDVs) a property must be referenced in combination with a point. The point description should be enclosed in brackets and placed in front of the property with a dot (.). For example to reference humidity ratio at point "Pt1", you would enter [Pt1].[W]

Variables
Previously defined user defined variables may be used in an equation for a following user defined variable. The variable is referenced inside the equation by placing the assigned symbol inside brackets [] (for example [MyUDV]). It is important to note that if a user changes a variable symbol, any dependent equations are not updated and become invalid.

Chapter 5: Modeling

Introduction

There are two important considerations when defining a model of a psychrometric process using this software. The first is the selection of the types of points, and the second is the selection of properties used to define the points.

The program provides for three types of points: Entry, Process, and Mix points. The program then maintains the consistency of properties from point to point on the chart by performing appropriate material and energy balances.

Ideally once a model is defined it should be easy to perform "what if" scenarios by simply altering a single value at one of the points. By carefully selecting appropriate properties to define the points many different psychrometric processes can be modeled. It is possible to define a point by designating changes in properties from the previous point. We commonly refer to these properties as "delta" properties throughout this documentation, and they are a very important part of developing many types of models of psychrometric processes. The details for individual properties are presented in the PFL help document.

In general the program is based on a once through calculation model. It passes through the list of points in the order in which they are defined, and calculates all of the properties for each point, based on its definition and references.

Point Types

Entry Points:
An entry point is a completely unconstrained point. It is expected that the user will completely define the point using two specific psychrometric properties and a mass defining property (volume is a mass defining property). Any of the points characteristics can be indicated upon creation, or modified during editing. Entry points can be thought of as boundary points where air and/or water enters the system.

Process Points:
A process point is a partially constrained point. It inherits it's mass and volume rates from a reference point on the chart. By default the reference point is the immediately preceding point. In particular it inherits the mass of dry air property directly from the reference point. Under this scheme the program calculates all mass and volume rates for process points, and the user is not allowed to edit or change these values. A process point is the result of some combination of, cooling, heating, humidifying, or dehumidifying the air from the reference point. Energy and/or water is entering or leaving the system. The mass of dry air remains constant.

Mix Points:
A mix point is a fully constrained point. It inherits all of its properties and rates as a mixture of some combination of the preceding points. The mix point is assumed to be the result of combining two or more of the preceding points on the chart, and is calculated assuming both conservation of mass, and conservation of energy. No air, water, or energy is entering or leaving the system. Existing points are being combined. There must be at least two points on the chart in order to define a mix point. The first and second points in a system on the chart can never be mix points.

Exit Points:
An exit point serves as a point on the boundary where mass is exiting the model. There is not a designated point type of "exit". In previous versions of the Akton Psychrometric Chart the final point always served as the exit point. However in version 4 it is possible to split streams and have multiple exit streams. In such cases process and mix points that are not referenced become the exit points. It is also possible to mix an entry point with a negative mass to form an exit point.

Material Balances

Material balances are based on conservation of mass. Mass can enter the system in two ways. An entry point can contribute mass to the system, or a humidification process can occur. Mass can leave the system through dehumidification, or a process or mix point on the chart that is not referenced, which can be thought of as the exit point. The following statements high light the differences between point types in regards to material balances.

Conservation of Mass:
For our purposes, the conservation of mass is the principal that mass is neither created or destroyed in a psychrometric process. All mass entering the system must be accounted for in mass exiting the system. Mass in equals mass out.

Entry Points:
Entry points are fully unconstrained points, the user specifies the mass that is entering the system at these points. The mass may be specified as any of the mass related properties, which the program then converts to mass of dry air.

Process Points:
1 If moisture increases, then humidification has occurred. Water has been added to the system and the mass or mass rate is increased by the amount corresponding to the water that has been added..

2 If moisture decreases, then condensation or dehumidification has occurred. Water has been removed from the system and the mass or mass rate is decreased by the amount corresponding to the water that has been removed..

Mix Points:
For mix points conservation of mass is strictly the sum of the masses of the contributing points. Erroneous points are possible if the contributing points are all close to the saturation curve. An erroneous point should be obvious, it will exist on the wrong side of the saturation curve.

Energy Balances

Energy balances are based on conservation of energy. Specific enthalpy is defined relative to a state of zero enthalpy for both water and air in the PFL configuration. The absolute energy of a point is calculated as the mass (or mass rate) multiplied by the specific enthalpy. Both specific enthalpy and energy are split into latent and sensible components.

The first law of thermodynamics is often represented mathematically as follows:
Q - W = dEp + dEk + dEu
Where
Q = thermal energy crossing the boundary
W = work done by the system
dEp = change in potential energy
dEk = change in kinetic energy
dEu = change in internal energy

In psychrometrics W dEp dEk are often neglected and assumed to be zero.
This leaves:

Q = dEu

Conservation of Energy:
The first law of thermodynamics states, that energy is neither created nor destroyed, but rather that it is conserved. That is to say that all the energy that enters a system must be accounted for in the energy that exits a system. Energy in equals energy out. The program assumes adherence to the first law.

Process Points:
Sensible energy is calculated as the mass times the specific sensible energy (Es = ma x hs) for all points. Latent energy is calculated as mass times specific latent energy (El = ma x hl) for all points. For process points the change from point to point for sensible and latent energy is calculated as Qs = (Es at point 2) - (Es at point 1) and Ql = (El at point 2) - (El at point 1). A third term is calculated for any water entering or leaving the system Qw = dm(t - tzero)Cp H2O liquid. Total energy is then Qtot = Qs + Ql - Qw. If water is entering or leaving in the process it may contribute to a change in the energy term. It is assumed that if water is removed, it is removed as liquid at the **final** temperature. If water is added, it is added as liquid water at the **initial** temperature.

Mix Points:
Mixing is calculated by summing the energy and the masses of the contributing points. This is used to determine the specific enthalpy and humidity ratio of the resultant point. Erroneous points are possible. An erroneous point should be obvious, it will exist on the wrong side of the saturation curve.

Modeling Tips

Identify boundary conditions:
A helpful first step in building a model is to identify the boundary conditions. These are the points where moist air is entering or exiting the system. They are not dependent upon other points on the chart. Entry points usually represent boundary conditions.

Identify process points:
It is helpful early on to identify the process points. (Any points that are dependent upon another point in the model.) Then determine the defining parameters for these points. (The properties that best represent the process being modeled.) Often these properties relate directly to equipment capabilities, specifications, or operating parameters. Often these should be delta properties (properties that describe a change from a previous condition or point).

Using a negative mass:
In a more complicated model it may be desirable to represent an exit point that is not the final point of the process. A bleed stream is an example, and can be represented by creating an entry point with a negative mass and mixing it with a process stream. By using the advanced process point options, a process point can also be used to represent an exit point in a model.

Ambient Conditions:
In many model it is useful to create an ambient conditions point early in the definition of the model. This point can then be referenced by multiple points later on using the advanced options features. The model can then easily be used to evaluate a complex process or model under various ambient conditions by editing the values for a single point.

Splitting a Stream:
A stream can be split by referencing a single point multiple times from following points and assigning appropriate proportions of that point to the points that reference it. A split stream can later be mixed again using a mix point.

Using a point above the saturation curve:
In many cases it is useful to create an intermediate point that lies above the saturation curve, even though such a point can not really exist. Then define a process that returns to a realistic condition. For example: It is possible to inject steam into an air stream knowing it's specific enthalpy and obtain a point above the saturation curve. By adiabatically moving to the saturation curve the resultant air conditions and condensation rate can be determined.

Define complex or abstract units:
It is possible to define unit conversions that perform more complex or abstract calculations. A simple example would be to define a unit conversion that translates kilowatt hours into energy costs.

Advanced Process Point Options
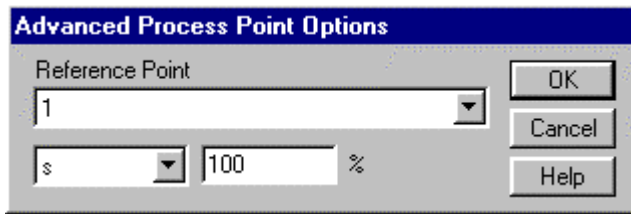
The advanced process point options provide a means to select a reference point. A process point can have its mass calculated as a percentage of the reference point's mass by using the split ratio property, or it can be defined as a quantified mass property at the conditions of the reference point. By default a process point has it's mass calculated using 100% of the mass of dry air from the reference point.

Reference point;
The reference point is used to calculate the mass property of the process point. By default a process point will reference the preceding point in the list of points. Only preceding points in the list of points may be used as a reference point for any given process point.

Mass Property
A mass defining property must be selected.   The property selected will be used to calculate the mass of the process point. The process point is then defined as the result of taking the indicated quantity of air from the conditions of the reference point. By default the split ratio property is assumed and is assigned a value of 100%.

Numeric Value
The numeric value indicates the amount of air (in the units as indicated for the selected mass defining property) to be taken at the conditions of the reference point. It is important to understand that the value assigned here does not refer to the mass of the current point, but rather to the mass that is to be inherited from the reference point.

Advanced Mix Point Options
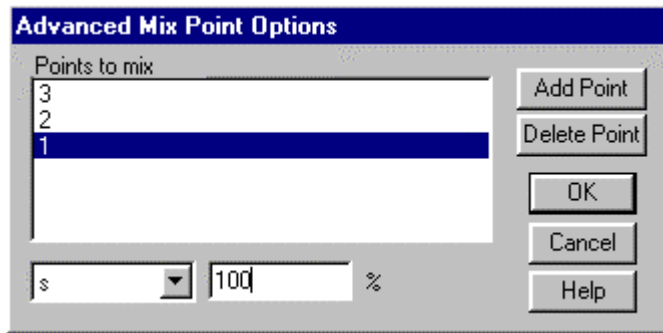
A mix points can reference any combination of the points that have been defined before it.   Each of the points that are referenced can be mixed in their entirety, in some proportion, or be given a quantity of air at the reference conditions.

Points To Mix
This is the list of points that are to be referenced during the calculation of the mix point. Points can be added to the list by using the add point button. The currently high lighted point can be deleted by clicking on the delete button. Only points that have been defined before the current point can be referenced for mixing. The currently high lighted point indicates which point the other elements of the dialog box pertain to.

Mass Property
The mass property drop list indicates which mass defining property will be used for the currently highlighted point, when creating the mix point. By default the split ration property is selected with a value of 100%

Numeric Value
The numeric value indicates the amount of air (in the units as indicated for the selected mass defining property) to be taken at the conditions of the currently high lighted reference point. It is important to understand that the value assigned here does not refer to the mass of the current point, but rather to the mass that is to be inherited from the reference point.

Add Point
The add point button provides for adding points to the list of points to be mixed. Click on the add point button and a list of all the previously defined points will appear. Select the point you wish to add, and it will appear in the list.

Delete Point
The delete point button can be used to delete a point from list of points to be mixed. If you click on the delete point button, the currently high lighted point will be deleted from the list.

Chapter 6: Data Exchange

Introduction

The Akton Psychrometric Chart supports several methods of exchanging data with other Windows programs.

With the release version 4.1 there is an add on package of ActiveX controls that can be used to perform a variety of calculations and chart manipulations from most any program that supports ActiveX controls. This is the most obvious means of interfacing the chart program's capabilities into another program or software package. We are calling the ActiveX package Akton PsychrometriX and it is freely available to users of APC 4.1 or later for runtime usage. The DDE and ODBC capabilities of this program are somewhat legacy features left in place from previous versions.

The simplest way to transport data is to use the windows clipboard. This is typically cut, copy, and paste under the edit menu of many popular windows applications. This is a very quick and convenient way to move data to another application, and is probably the most frequently used. Where this is very convenient, it does have the disadvantage of being a static copy that can become out of date and incorrect.

Dynamic Data Exchange (DDE) is a more sophisticated solution to transporting data. There does however seem to be considerable variation in how Windows programs implement DDE. Our implementation is a rather simple one, targeting spreadsheets such as Microsoft's Excell as the primary type of DDE client.

The Microsoft Open Database Connectivity (ODBC) interface, is a convenient way to exchange data for people who are accustomed to working with, or writing database applications.

The chart program also supports some drag & drop capabilities, as well as a file association open file response. These typically interact with programs that provide shell functionality.

Using The Windows Clipboard

The Windows clipboard is the simplest and most common data exchange tool that is available in many popular Windows applications. Most software applications implement the clipboard in the form of cut, copy, and paste commands under the edit menu.

The Akton Psychrometric Chart for Windows only supports copy. This provides a simple but effective way to get the chart and the report into many other popular windows programs including but not limited to Word Processors and Spread Sheets.

To copy either the chart or the report to the clipboard, simply choose the copy option from the edit menu. This will place a copy of the chart or report on the clipboard. The chart program will display no visible cues during this process, however the receiving program will usually have it's paste option enabled where it was not enabled before.

The chart is copied in the form of a metafile picture. Only software applications that support metafile pictures on the clipboard can paste the chart image. Software applications that are capable of working with vector graphics often will allow the user to further edit and manipulate the image. Microsoft's Word has historically done a nice job of this. Autodesk's AutoCAD can also manipulate the image, but requires more expertise in use. These are by no means the only other applications that have this capability.

The report is copied as simple text. A text string that is essentially the same as is displayed in the report window, is copied to the clipboard. Any software application that supports text on the clipboard can paste the report. It is important to note that the columns on the report are tab delimited. For most text editors, the tab setting in the receiving program must be adequate to accommodate the longest name and/or number in order for the columns to line up. Usually the tab setting can be adjusted before or after the paste operation. Editors that don't support tab settings (such as the windows notepad) are awkward to use for this purpose. Spread Sheet programs usually interpret the tab as an indicator to move to the next column, and paste the image nicely regardless of tabs settings or column widths.

Using Dynamic Data Exchange (DDE)

Version 4 of the Akton Psychrometric Chart supports two types of DDE exchanges: DDE request, and DDE poke. In general there are three parameters necessary to initiate a DDE connection. These parameters are frequently referred to as the *application*, *topic*, and *item*.

The *application* refers to the name of the program that is going to act as a server of information. In using this software this is always going to be *akpsych4*, this corresponds directly with the name of the execution file. In order for the requesting program to find the program and exchange data, it must be able to find this file (akpsych4.exe) in one of three ways. One: The program is currently running in memory. Two: The file can be located by examining the path environmental variable. Three: The file is in the current working directory.

The *topic* is commonly used to designate the document that is to be opened by the information server program. In the chart program this is one of the files created by the program, usually designated by the extension *psy*. This can be either the entire file name including dive and path for the file, or it can be just the file title and extension. It is recommended to use just the file title. This makes it easier to move the chart file to a different directory, and have your DDE connection still work. This does require that the chart be opened and loaded into memory before the client program is started. In some cases it may be more reliable to use the entire file name, including, drive letter, directory, filename, and extension.

The *Item* is used to designate a program variable. The syntax for referencing program items is the same as for user defined properties and variables. Current property values are referenced by placing the properties symbol in brackets. (example [W]). A property value at a point can be referenced by preceding the property symbol with the point description (example [Point1].[W])

In general it is best to build a preliminary model using the chart program and then connect up to it using a spreadsheet such as Excel. At present the DDE connection does not support adding or deleting points on the chart, only altering existing points. Existing points on the chart can have both their values and defining properties changed through the use of the DDEpoke method. DDEpoke is a object method in the VBA language that is part of Microsoft's Office applications. Values can be received from the chart program through the use of the DDErequest command.

DDE Example:
If you installed the example files that are distributed on the program diskettes, then there should be an example Excel spreadsheet and an accompanying chart file in the installation directory. The example files are evapcool.xls and evapcool.psy. The simplest way to experiment with the example is to first open the psy file using the chart program, and then open the xls file using Excel. Excel should prompt to reestablish links when the xls file is opened. The example was created using Microsoft Excel version 7.0 for Windows 95.

DDE request:
The following is an example of using DDE request to embed values into an Excel spreadsheet. By entering the following into a cell, the value displayed in the cell should be updated as the cursor is moved over the chart.

=akpsych4|filename.psy![W]
It may be necessary to place the topic and/or the item in single quotes
=akpsych4|'filename.psy'!'[W]'

To embed a point value into an Excel spreadsheet you could enter the following into a cell. The value displayed in the cell should be updated whenever the value is changed on the chart.

=akpsych4|filename.psy![Point1].[W]
Again it may be necessary to place the topic and/or the item in single quotes
=akpsych4|'filename.psy'!'[Point1].[W]'

DDE poke:
The following is an example of poking a value into an open chart in the chart program using the VBA language from inside an Excel macro sheet.

```
Sub setpoint()
    channelNumber = Application.DDEInitiate( app:="akpsych4", topic:="filename.psy")

    Set rangeToPoke = Worksheets("Sheet1").Range("B2")
    Application.DDEPoke channelNumber, "[1].[h]", rangeToPoke

    Set rangeToPoke = Worksheets("Sheet1").Range("C2")
    Application.DDEPoke channelNumber, "[1].[t]", rangeToPoke

    Application.DDETerminate channelNumber
End Sub
```

File Association and Drag & Drop

The Akton Psychrometric Chart supports these common forms of shell functionality.

File association allows a file type (PSY in this case) to be associated with an application (akpsych4.exe in this case). This allows a user to double click on a PSY file inside a shell file manager such as Windows Explorer, and have the program automatically start up with the indicated file loaded. Sometimes other software applications can harness this capability. The practical way in which this is done is simply to provide the file name as a command line parameter when executing the program. Windows Explorer provides a means for users to associate files. The setup program that comes on the distribution disk attempts to make this association automatically during setup.

Drag & drop allows a file to be dragged from a program shell such as Windows Explorer, and be dropped on an open application. This provides a convenient way to quickly review or search charts. Simply click and hold on a PSY file inside Windows Explorer, and then drag the file to the main chart window. When you drop the file on the chart window the program should load the selected chart file. Although less likely, it is possible for other Windows applications to take advantage of this capability.

ODBC Configuration

In order for the ODBC feature to work you must:

Have an ODBC core level compliant driver installed on your system for the database format you choose to use.   Drivers are usually available from the software vendor who develops or sells the database product. Akton does not sell or redistribute ODBC database drivers. Refer to your database documentation for information on the availability and acquisition of ODBC drivers.

Have that database properly configured as an ODBC data source. This is usually done by using the ODBC configure utility that usually appears in the windows control panel. The database is assigned, a driver and, a data source name.

Have a compatible table structure into which rows can be inserted. There is an example database that was created using Microsoft's Access version 7.0 for windows 95 supplied with this product. It is in the installation directory under the name of "example.mdb."

Version 4 of the Akton Psychrometric Chart behaves essentially the same as version 3 did. It does however use 32 bit ODBC, and therefore requires 32 bit drivers.

Table Structure

In order to use the ODBC database transfer feature of this software package, the user must create a compatible table structure into which, this software can successfully insert a row. After a successful connection has been made using the given connection parameters, a series of SQL insert commands are sent to the database driver. Any error messages that are returned by the driver, are displayed for each insert command. SQL stands for Structured Query Language.

The insert command will have one of two formats depending on whether the "Include Units" option has been selected. Only the reported properties as appearing on the current "process report" will be inserted in to the command. Below is the format of the insert command.

If units are not selected:

INSERT INTO <TableName> (DataName, Descr, Type, <prop1symbol>[,<prop2symbol>,...])
VALUES ('<DataSetName>','<PointDescription>','<PointType>', <prop1value> [,<prop2value>,...]
)

If units are selected:
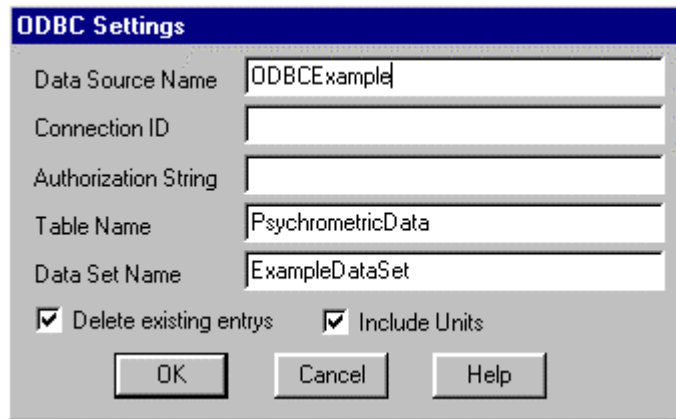
INSERT INTO <TableName> (DataName, Descr, Type, <prop1symbol>, Units<prop1symbol>
[,<prop2symbol>,Units<prop2symbol>,...])
VALUES ('<DataSetName>','<PointDescription>','<PointType>', <prop1value>, '<prop1units>'
[,<prop2value>,'<prop2units>',...])

The values between <> ie <example> are place holders for parameters that are determined when the transfer is attempted. They correspond to the attributes of the properties and points being transferred, or the ODBC connection settings.

It is important to note that the first three columns in the insert command have fixed names (DataName, Descr, Type). It is required that the table have these three text columns defined in the table. All other elements of the insert command are related to the attributes of the properties and points as selected by the user. With the exception of the <value> columns, all columns should be text columns of appropriate length. The <value> columns should be able to accommodate the domain of real numbers applicable to the property values.

A common schema for creating this table is to create columns for all the properties that are anticipated to be needed, and then configuring the database manager such that they are allowed to be null. The program will not attempt to insert values for properties that are invalid for a point type.

ODBC Settings Dialog Box

Data Source Name
The data source name is the name of the data source as configured with the ODBC administrator. ODBC administrator can usually be invoked from the control panel for systems that already have ODBC drivers installed on them. This parameter can not be blank.

Connection ID
The connection ID is a user identifier as is supported in many database implementations. It can be left blank in many cases. If your database has been created in a secure fashion, making use of SQL grant and revoke commands, then you may need to use this parameter.

Authorization String
The authorization string is a verification parameter much as a password. These values are stored in the <chartname>.PSY file, so care should be taken in the granting of table access if you are working in a secure environment. This parameter can be left blank in many cases.

Table Name
The table name parameter is the name of the table in the data source database, in to which the results are to be inserted. This table must have the proper physical structure as described in the database configuration documentation. This parameter can not be blank.

Data Set Name
The Data Set Name is an identifier for the purpose of distinguishing between different sets of results in the same database. Some ODBC database drivers will generate an error if this parameter is left NULL.

Delete Existing Entries
If the Delete Existing Entries check box is selected in the Database Connection dialog box, any existing entrees in the specified data destination that have the same Data Set Name will be deleted before new values are inserted.

Include Units
This check box indicates that the program will attempt to transfer the units for each property as well as the values.

Chapter 7: The Process Menu

The Process Menu

The intention behind this feature is to make it easier to repeat many routine point definitions. It can be used to recall a process that describes a certain piece of equipment that may need to be described on the chart frequently. It can provide a quick means to move to a common design point.

Any time a process point is created on the chart it can be saved. Once saved it can be recalled at any time that a process point is to be defined on the chart. In version 4 Entry points can also be saved, but we left the menu with the same name.

Process
<u>S</u>ave
<u>D</u>elete ▶
Heat/Cool
Humidify/Dehumidify
Center

Saving a Process

To save a process first define it on the chart as you would normally. Give the point a description you would like added to the process menu. After the point is defined on the chart, and while it is the last point on the chart, choose the "Process Save" menu pick. This will save the process in the SP file, and add it to the menu using the description you assigned to the point.

Deleting a Process

To delete a process from the menu, pick the process from the delete sub-menu. The process will be deleted from the SP file and be removed from the menu.

Recalling a Process

To recall a process, pick it from the process menu. This will bring up the Creating Point Dialog Box with the properties and values as defined when the process was saved. You can now edit or alter the parameters if necessary. The Creating Point Dialog behaves like it normally does, but it starts out with the properties and values from the process you saved.

Process Menu Configuration

The information used by the process menu is stored in a separate file. The file is located for use by the program by examining an entry in the Windows registry. The program expects to find an entry for "SPfile" = under the "HKEY_LOCAL_MACHINE\software\akton\psychrometric chart\4.0" chart key. This should be the complete path and file name of the file. By default during setup the file is specified to be "akpsych4.sp" in the program installation directory. If the file is not found at the designated location, the program will give an error message at start up, and then attempt to create the file the first time a process is saved. SP was selected during development to stand for "Saved Process".

Chapter 8: Background

Program History

Akton Associates Inc. is an active engineering consulting company. The Akton Psychrometric Chart arose out of a program we used internally for the analysis of fan curves, using fan laws. It was intended to provide a familiar graphical interface for the specification of operating conditions in the analysis of fan performance.

Version 1 was a very simple program with the primary capabilities being the calculation of psychrometric properties over a wide range of conditions. It did not even provide for the storage or recall of chart files. It did however support the windows clipboard very much as it does now, though the image was much more primitive. The publication and distribution of version 1 to others can be largely regarded as a learning experience.

Version 2 was designed to address the majority of complaints and suggestions that arose from version 1. The calculations portion remained mostly unchanged. Our effort was focused on improving the program interface to aid in solving more complicated real world problems. We implemented some modeling capabilities but were limited by the initial design of the calculation engine. We implemented file storage and recall, and a simple ODBC database connection. We also added to the property list.

Version 3 represents an almost complete rework of all the components. The primary thrust was to redesign the calculation engine to support a greater list of properties, that could easily be added to in the future, and provide for more sophisticated modeling capabilities. The larger and perhaps even variable property list required a complete re-write of the interface module as well. In response to user requests we elaborated upon the graphical plotting capabilities. Version 3 draws both a more realistic and efficient chart. The menu was re-mapped to be more congruent with other windows applications, and the contents of the process menu was placed in the user's domain. Many other features have been added or improved upon as well.

Version 4 is the first true 32 bit windows version. Version 3 was ported to the win32 environment, and as such was freed from many of the memory restrictions that where inherent in 16 bit Windows. User defined properties where added, the 31 point limit was eliminated, the modeling engine was enhanced to provide for splitting and re-mixing of streams. Support has been added for DDE poke. In general version 4 is a far more powerful modeling tool.

In Version 4.1 we implemented Crypkey Licensing control, we made some necessary changes to support the ActiveX control add on, and we made a series of small fixes and enhancements. We also made all of documentation available in PDF Format.

Program Philosophy

This software was developed primarily to be a calculation aid in the solving of problems in psychrometrics. It has been designed to be as flexible as possible so that it may be applied to many different areas of engineering. Although it may work as a learning aid, it was not meant as a substitute for an understanding, or study of psychrometrics and the underlying classical thermodynamics. In general we have found that people that have an understanding of their problem sufficient to solve it on their own using a conventional psychrometric chart, usually find our program reasonably easy and useful to apply. People who purchase our software hoping it will help them solve a problem without understanding the problem, are often disappointed.

This software is intended to be used in conjunction with other windows software. Some users have complained about inflexibility in the printing of the chart. We do not intend to develop any sort of sophisticated graphical editor. There are many good ones already out there. We have gone to considerable effort to develop a graphical image that can easily be copied into and edited by other popular windows software. If you want to add titles, comments and other features to improve, or elaborate upon, a presentation, you should copy the chart and/or data into your favorite windows word processor, spreadsheet or publishing tool.

A Discussion of Psychrometrics

There are several approaches to the generation of psychrometric charts. The most common is a chart constructed using humidity ratio and enthalpy as the two axis. The enthalpy axis is skewed to an angle that gives the appearance that dry bulb temperature is the horizontal axis. On a chart of this kind dry bulb temperature is not an axis. Dry bulb temperature is plotted against the axes, the result appears linear but the slope changes over the temperature range. Specific volume and relative humidity are also plotted, and the result is not linear.

The reason behind plotting the chart in this fashion is to facilitate solving problems on the chart graphically with a minimum of error from thermodynamic approximations. Because the moisture content and the enthalpy are linear and have a constant slope, any ratio of change in these properties will also have a constant slope over the entire chart. A protractor is normally printed in the upper left hand corner of the chart. The protractor provides the slope of two very useful ratios that can be used to solve many common psychrometric problems; the ratio of change in specific enthalpy to the change in humidity ratio, and the change in sensible heat to the change in total heat. The first is useful in solving humidification problems such as injection of saturated steam, and the second is useful in solving heating and cooling problems. The slope of the line that represents these ratios can easily be applied to any point on the chart by drawing a parallel line through the point.

A chart generated in this fashion also makes it easy to solve for the mixing of two air streams. It is normally solved by locating the two input streams, drawing a straight line between them, and then using the ratio of dry air for the two streams, to locate the resulting point.

In the development of this computer software we implemented a chart that was based on humidity ratio for the vertical axis, and dry bulb temperature for the horizontal axis. We chose to use these axes to facilitate the empirical calculations. By using these axes we felt we could provide a chart with greater flexibility over a larger range of conditions, and for a greater number of properties. It is numerically easier to calculate enthalpy as a function of temperature than it is to calculate temperature as a function of enthalpy. This is true of many of the other properties as well.

Although the user is interacting with a graphical image of the chart, the values for the entire property set are actually being solved for empirically or numerically, and such it is possible to work with many properties that are not directly available on a conventional psychrometric chart.

It has often been called to our attention that our chart lacks the protractor in the upper left hand corner that is commonly available on published charts. There are several reasons for this. One is the axes we have chosen. Because specific enthalpy is not linear on our chart, the slope of these ratios may change at differing points on the chart. This becomes increasingly apparent if you increase the temperature range. It could be said that there is actually a different protractor for each point on the chart. Another reason is that we allow three of the properties on the chart to be generated on a moist air basis. This can greatly alter the linearity of properties, depending on the combination that are selected to be on a moist air basis. Therefore; we provide the use of these ratios within our properties listing so that the slope can be determined as the ratio applied at each point on the chart.

Ideal gas laws are used in the calculation of volumes, partial pressures and related properties. You may want to get a thermodynamics text, and review Boyle's, Dalton's and Amagot's Laws of ideal gases. Water does not behave as a perfect ideal gas. Especially as you approach the critical point. For many applications the difference is acceptable if not negligible. However as an engineer you should not neglect this consideration, especially if you are working at high pressures and high moisture levels.

We have encountered much confusion in regard to the state of zero enthalpy. Specific enthalpy is an arbitrary value and can change for a given state of a moist air mixture from one system of units to another. It is strictly by convention that the English system uses zero degrees Fahrenheit as zero for air, and the metric system uses zero degrees centigrade as zero for air. We have observed cases where an engineer has worked from sources in both systems of units without taking this into account. When viewing most published charts, you can NOT convert a specific enthalpy value from a metric chart and have it match the value you read from an English chart.

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