

# EESy Solutions

Engineering Equation Solver Newsletter

No. 21, Spring 2011

## Welcome

This is the 21<sup>th</sup> issue of **EESy Solutions**, a newsletter developed to provide news, tips, and tricks relating to Engineering Equation Solver. EES has been a commercial software product for over 20 years. Did you miss any of the previous issues? The previous issues are available from our web site: <http://fchart.com/ees/>

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## Instant Update Service

EES uses a different model for updating than most other commercial programs. Each time there is a change in the EES program, either to correct a problem or to add a new feature, the version number is incremented by 0.001 and the latest version is placed on our website. Although the program has become very robust and stable, there have been **250 new versions** released since the last EESy Solutions was composed in Spring 2010. Any user who has a current subscription to our Instant Update Service can download the latest version. All new licenses of EES are provided with one year of Instant Update Service. The fee to continue Instant Update Service after the first year is 20% of current cost of the program per year. Contact F-Chart Software if you wish to re-subscribe to Instant Update Service.

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## What's New?

Have you visited F-Chart.com recently? If you haven't you may be surprised as we have completely revised and modernized our website. The new website is more attractive and responsive, and it allows for easier access to information concerning all of the F-Chart Software products. The website provides a user forum, which allows users to post questions and tips. To access the forum, click on the Support button at the top right of any fchart.com page. If you have a suggestion for an enhancement, enter it in the forum or send it to [info@fchart.com](mailto:info@fchart.com).

Some of the new features that have been added in the last year are as follows:

## Brine Properties

Property data for brines (secondary refrigerants) have been available in EES with the BrineProp2 external procedure, originally contributed by users at KTH, Sweden. However, many users were unaware of these data because they were not documented in the EES help file. The property data have been updated based on new information in the IIR publication by Melinder (2010) <http://www.iifir.org/en/details.php?id=1177>. In addition, the brine property data have been built into EES so that they can be accessed in the same manner as other property data in EES. For example, the following EES code returns the density of a 50% ethylene glycol-water solution at 10°C:

```
$UNITSYSTEM SI C kPa kJ  
rho=density(EG,T=10 [C],C=50[%])
```

Specific heat capacity, density, freezing point, thermal conductivity and viscosity data for 13 brine solutions are provided.

## Revised Function Information Dialog

With the addition of the brine properties and the NASA data (see EESy Solutions, 2010), there are now 5 different groups of built-in property data. The groups are: real fluids, ideal gases, NASA data, brines, and psychrometric data. Not all of the property functions apply to all fluids. For example, the Quality function is applicable only to real fluids and the FreezingPt function is only applicable to brines. The Fluid Information section of the Function Information dialog has been rewritten to present the possible choices of functions and fluids more clearly. The dialog now provides radio buttons to select the fluid group and then displays the property functions and fluids that are applicable to that group.

## Additional Property Data

Property data have been added for acetone, R1234yf, R1234ze, sulfur dioxide, HFE7500, and R13B1. Property data for mixtures of lithium chloride-water have been implemented based on correlations from Patek and Klomar, Int. J. Refrig., Vol. 31, pp. 287-303, (2008).

### Equations Window Status Bar

A status bar has been implemented at the bottom of the Equations window. The status bar shows the position of the cursor, and settings for word wrap, Caps lock, Insert mode, unit system, warnings, unit checking, and complex math mode. Clicking on any of the settings in the status bar toggles their values. The status bar also displays the units that EES is set to operate in. Clicking on the unit setting opens the Unit System dialog where the unit system choices can be changed. The status bar can be disabled by clicking in its leftmost panel area.

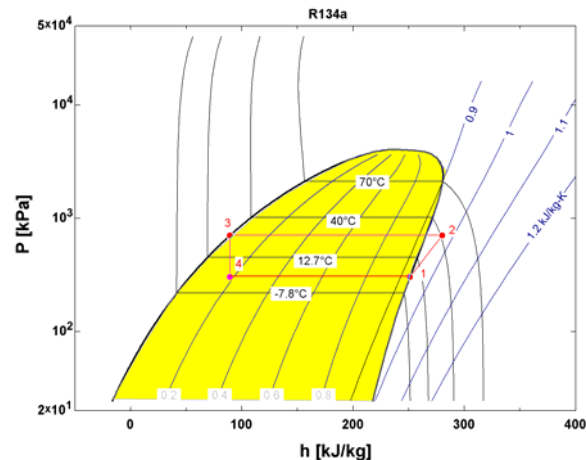
### Enhancement to the Arrays Window

Experienced EES users know that, in addition to the equations in the main body of EES, equations can be implemented in Functions, Procedures, Modules and Subprograms. Functions and Procedures allow equations to be entered in a manner similar to most programming languages, with logic constructs such as IF-THEN-ELSE and REPEAT-UNTIL. Functions return one value while Procedures return one or more values. Modules and Subprograms essentially implement a separate EES program that can be called from the main program. The equations in a Module are transparently combined with the equations in the main program whereas Subprograms provide a totally independent workspace.

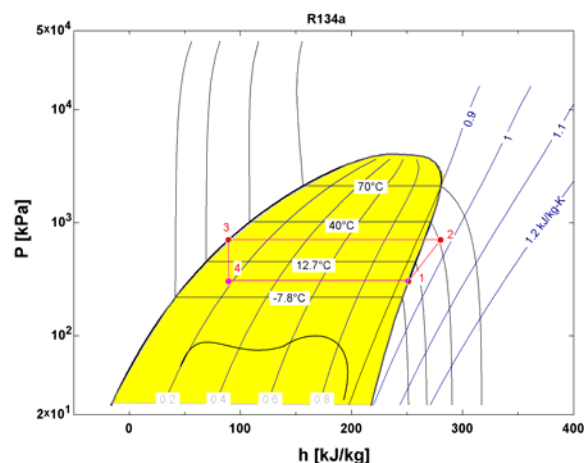
Functions, Procedures, Modules and Subprograms all allow the use of array variables in which the array index (or indices) are provided within square brackets, e.g., X[3]. However, until version 8.780, only the array variables in the main body of the program could be displayed in the Arrays window. That limitation has been removed. Array values that are defined in Functions, Procedures, Modules and Subprograms can now be optionally displayed in a separate tabbed window of the Arrays window by placing a \$ARRAYS ON directive at the start of the equations. The array values appearing in the Arrays window can be plotted and copied in the same manner as for data in any other table.

### Polygon and Polyline/Bezier Drawing Tools

Two new drawing tools have been added to the Diagram and Plot windows in the Professional version. The polygon tool allows a shape to be entered with up to 500 points that can be filled with an opaque or transparent color. One use for this capability is to highlight irregular areas, such as the vapor dome shown in the figure below.



The polyline tool allows a multi-segment line series to be constructed. This in itself may be useful, but an additional capability is that the polylines can be smoothed using Bezier curves. To smooth the polyline, right-click on one of the line segments and then select Properties from the popup menu. Click the Smooth checkbox. When the toolbar is visible, both the line segments and the smoothed Bezier curves will be visible. Only the Bezier curve is visible when the tool bar is hidden, as shown in the figure below.



### Uncertainty Propagation

One of the more powerful capabilities in EES is its ability to numerically determine partial derivatives of any variable with respect to any other variable and use this information in uncertainty propagation calculations. The capabilities of the uncertainty propagation calculations have been enhanced in the Professional version. It is now possible to determine the uncertainty propagation of up to 50 selected variables in terms of the uncertainties of up to 100 measured variables. The Uncertainty Propagation dialog window can be resized to allow easier selection of calculated and measured variables. The uncertainty analysis section of EES has been recoded to allow simultaneous determination of the uncertainty propagation of all selected variables, which results in a very significant reduction in the computation time needed to complete the uncertainty analysis.

### \$MaxCalls Directive

The \$MaxCalls directive places an upper limit on the number of times a Function or Procedure can be called during an iterative calculation. This ability is useful in some situations in which logic statements are employed. Use of an IF-THEN-ELSE statement, for example, can result in a repeated sequence of on/off decisions and convergence thereby becomes impossible. When a \$MaxCalls directive is provided, there will be an upper limit on the number of times the equations within the Function or Procedure are evaluated. If the number of calls to the Function or Procedure exceeds the specified limit, the Function / Procedure will return the same results as it did for the last valid call, which prevents alternating values and allows convergence.

### \$Constant Directive

The \$Constant directive allows a constant to be locally defined within an EES program. This directive is normally placed at the top of the Equations Window, before any Functions,

Procedures, Modules, Subprograms or equations in the main body of the program. The format of the \$Constant directive is:

```
$Constant N#=100  
$Constant NP1#=#N#+1  
$Constant R#=#'R134a'
```

Note that constants are identified with the # character, which must be the last character in its name unless the constant is a string. A string constant name ends with characters #\$. Constants are effectively global variables that can be used in any Function, Procedure, Module or Subprogram, as well as in the main program.

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### *Macros*

We receive many email questions asking if EES can do this or that. The general answer to this question is yes, it's possible, using a macro. An EES macro is a script that automates a series of actions, similar to a MATLAB script. Macros are only available in the Professional version. Nearly everything that can be done in EES from a menu command can also be done in a macro.

Macros are easy to write. Select the Open or Create Macro menu command in the File menu to create a new macro. A macro window that shows the macro commands will appear at the bottom of the screen. Macro commands will automatically appear in this window as you select menu commands. (You can prohibit the macro window from being changed by clicking the lock button on the macro window toolbar.) Click the green arrow button on the macro toolbar to replay the macro commands.

Macro commands can also be entered directly into the macro window. There are many macro commands, as listed in the online help. This list of commands continues to grow and the functionality of existing macro commands has been increased. Some of the improvements added this year are as follows.

The ADDPLOTTEXT macro command allows text to be placed on plot windows from a macro.

A play macro button becomes visible in menu tool bar (just below the menu bar) when a macro window is open.

Macro commands that work with plots can refer to the plot by specifying the name of the plot window tab in single quotes or with a pre-defined string variable.

The line number, color number, symbol number and symbol size in the Macro NewPlot and OverlayPlot commands can be entered as integers or as the values of EES variables that are defined in the macro or EES program.

A popup menu will appear when you right click in the macro window, offering the usual editing commands and a command to comment or uncomment all selected lines.

The Find command is active in the Macro window.

The ShowWindow Progress macro command will display the progress dialogs that are normally hidden when a calculation is initiated in a macro script.

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### ***Textbooks***

A limited academic version of EES is distributed with a number of McGraw-Hill textbooks. See <http://www.mhhe.com/engcs/mech/ees/books.html>

The ***Heat Transfer*** textbook by G.F. Nellis and S.A. Klein (Cambridge University Press, 2008, <http://www.cambridge.org/nellisandklein>) is the first textbook that directly integrates EES with the engineering content. The book includes many detailed EES example problems that solve a variety of heat transfer problems from start to finish. In addition to demonstrating heat transfer principles, the examples illustrate many capabilities and best practices for using EES. The heat transfer libraries that are now provided with EES were developed in conjunction with this textbook.

A thermodynamics textbook integrated with EES by the same authors, will be released in 2011.


### ***Tips and Tricks***

It is often necessary to draw a horizontal, vertical, or 45° angle line on a plot or in the Diagram window. This is easily done by holding the Shift key down while drawing the line.

All text and graphic items in the plot and Diagram windows can be precisely moved using the arrow keys. Pressing the arrow key once moves the item by one pixel. Holding the arrow key down will cause the item to quickly move in the direction indicated by the arrow key. Pressing the Ctrl key while holding the arrow key depressed will slow the movement.

Warning messages are generated by EES during calculations for many reasons. Warnings provide information that the user should be made aware of, but is not serious enough to halt the calculations. Warnings normally appear in the Warnings window. However, they will not appear if the warnings have been turned off. One way to turn warning messages on or off is by clicking the Warning section of the status bar in the Equations window. EES will normally indicate the number of warnings that appeared in the Solution window. Clicking on the word 'Warning' will open the Warnings dialog and display the warnings.

The unit inconsistency messages that EES generates after solving are warnings and they in no way affect the values of calculated quantities. The messages can be ignored, although this is generally not a good idea. Some empirical equations will always result in unit inconsistency messages. However, these messages can be individually turned off by placing a \$CheckUnits Off directive before the equation that causes the message. Place a \$CheckUnits On directive after the equation to turn unit checking back on.

Add additional rows to a Parametric table by increasing the value of Last Row in the dialog that appears after clicking the  button.