EESy Solutions

Engineering Equation Solver Newsletter *No. 16, Spring 2006*

Welcome

EESy Solutions is a newsletter developed to provide news, tips, and tricks relating to Engineering Equation Solver. **EESy Solutions** is provided at no cost to all users of EES. Did you miss any of the previous issues? These newsletters and other useful information can be downloaded from our web site: www.fchart.com.

Instant Update Service

EES is updated more frequently than most other commercial software. Each time there is a change in the 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. There have been over 220 new versions released since the last EESy Solutions was composed in Spring 2005. Any user who has Instant Update Service can download the latest version. All new licenses of EES are provided with one year of Instant Update Service. If your version of EES was purchased within the last twelve months, you can access the Instant Update server conveniently with the EES Instant Update menu item in the Help menu. 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 or use the website (fchart.com) if you wish to re-subscribe to Instant Update Service.

Academic Site Licenses

Both Academic and Academic/Professional site licenses are available to departments in educational institutions for a one-time fee of $1,000 and $3,750, respectively. See www.fchart.com for additional details.

What's New?

As in years past, literally hundreds of changes have made to EES during the past year. The capabilities of the program continue to grow. What follows is a short description of some of the more important new capabilities.

Listing of New Features

New features released with each version can be viewed by clicking the New Features item on the home page of our website.

Copying Equations

Results from EES are often copied into a report. To save time and eliminate errors, it is advantageous to be able to copy the equations from EES directly into a document. Equations are displayed in the Formatted Equations window. EES now provides three ways to copy one or more selected formatted equations. All three methods are accessed by selecting the equations and right-clicking the mouse. A popup menu will appear with three options.

1. Copy as EES picture
   The option to copy the equation as an EES picture is not new. This option places a copy of equation(s) as a picture onto the Clipboard. The picture can be then copied into a word processor or other application. The advantage of this method is convenience, but the appearance of the equation is often not as good as desired and the picture can not be edited.
2. Copy as LaTeX
   This option will place LaTeX translations of the equations on the Clipboard in text format. The text can be pasted into any LaTeX editor. For most users, it is faster to enter equations into EES and copy them to LaTeX than to enter the equations directly into LaTeX
3. Copy as MathType
   One or more equations can be copied from the Formatted Equations window and automatically translated into LaTeX or MathType in the Professional version. The MathType equation can be pasted directly into Microsoft Word or other applications where it can be further edited by MathType by double-clicking on the equation. MathType version 5 is required for this capability. MathType is available from Design Science at http://www.dessci.com/en/. To qoute one of our users, "this capability is really cool".

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Plotting

Plotting is also a very important capability provided by EES. EES produces high-quality plots that can be used directly for publication. Some of the recent improvements that have been made to the plotting capability are:

1. The 3D plotting routines have been updated so that EES will now run more reliably on modern video cards. If you have had a problem with the 3D version in the past, it may be cured with the changes in this version.
2. New plot window toolbar buttons have been added to zoom a selected section of the plot, display a crosshairs cursor, and to move the plot. When the crosshairs cursor is displayed, the coordinates at the cursor are displayed in the plot window title bar.
3. Axis values on plots can be drawn at an angle between -90° and 90° in the Professional version. The default is 0° for horizontal text.
4. Double-clicking on a text item in the Plot window when the Plot Window Tool bar is visible brings up a dialog that can be used to change the properties of the text item. This dialog now allows the font, font size, and font color to be applied to selected text, rather than to the entire text item.
5. Plots can now be saved in TIFF (.TIF) format as well as in bitmap (.BMP), JPEG (.JPG), Window meta file (.WMF), and Enhanced meta file (.EMH) formats. In addition, a plot can be copied to the clipboard as a high-accuracy bitmap or an enhanced metafile with properties that can be specified by the user in the Plot tab of the Preferences dialog.
6. An Update Contours button has been added to the Modify Plot dialog, which can be accessed by right-clicking on the contour plot. Clicking the Update Contours button will allow any of the information that was used to construct the contour plot to be changed.
7. In the Professional version, the Minimum, Maximum and Interval for plot axes may be specified with EES variables in place of numerical values.

Diagram Window

The Diagram window was so named because it initially was developed to provide a place to display a diagram of the system that was being modeled. The capabilities of the Diagram Window have grown substantially. It now provides a complete graphical user interface (GUI) that interacts with the user for data input and output in one or more windows. Buttons can be placed on the Diagram window to initiate calculations, show plots, link to other programs, save data, or display a help file. The Diagram window also provides powerful animation capabilities, as described in EESy Solutions No. 14. You may wish to try some of the animation examples accessible from the Example menu. Additional capabilities that have been added to the Diagram windows are summarized below.

1. A copy of a plot window can be displayed in the Diagram window (Professional version). The plot size and location can be selected. The plot is an exact copy of the selected plot window, so as the plot window is changed, the display in the Diagram window is changed.
2. A status bar is displayed at the bottom of the Diagram window when it is set in development mode. The status bar shows the cursor position and information about the item at the cursor position.
3. When a Save or Load Buttons in the Diagram window is given a name, EES variables become available that allow the button to be moved or hidden. A new variable, FileName$, provides the name of the Windows file that was last used with the Save or Load button. For example, LoadButton.FileName$ is the name of the file that was most recently loaded with a button named LoadButton. The filename can then be displayed on the Diagram window in the same manner as for other EES variables.
4. The navigation button(s) on a child Diagram window (Professional version) can be made visible or invisible by right-clicking on the window and selecting the Properties menu item from the popup menu.

General Program Improvements

1. The Function Information dialog has been modified to allow selection of the independent properties that are displayed in the example edit box. In addition, the index, e.g., [1] of EES variables representing properties in the example edit box can now be specified. The revised dialog is more informative for new users and convenient for experienced users.
2. The format for the Solid-Liquid property functions has been made to be more compatible with the existing property function format. Quotes on the substance name are now optional and the T= designator to indicate that the following quantity is a temperature can be used so that the format is similar to the themostatic property functions.
3. Numerical values can now be entered and displayed in Time Format. In this format, a decimal value is represented in hours, minutes, and optionally, seconds. For example, the value of 9.5041 will display in Time Format as 9:30:15. Values can be entered in Time Format in the Equations window and in the Parametric and Lookup tables.
4. Thermodynamic and transport data have been added for n-pentane, toluene, R236fa, R235fa, fluorine, hydrogen sulfide, and n-dodecane.
5. A Traceback button has been added to the error message dialog in situations in which an error occurs within a Function, Procedure or Subprogram. Clicking the Traceback button causes Traceback Information to be displayed in the Debug window to identify the sequence of routines that led to the error.
6. The number of times each equation is called is shown in the Residuals window.
7. Any line in Equations window that begins with characters // will be ignored.
8. The requirement that a subscript variable be defined before it is used has been relaxed.
9. Two-monitor support is provided for the main EES windows in the Professional version.

Macro Commands

A macro is a set of instructions to the EES processor. Macros are stored in text files with an .emf filename extension. Nearly all of the commands that can be entered from EES menus can also be entered as macro commands. For example, it is possible to set up a macro to open a specified EES file, solve the equations, construct a plot, open a Word document, copy the plot to the Word document, and then close both EES and Word. The macro can be initiated from the play button within the Macro window in EES or by starting EES from the command line with the macro file name provided as a parameter. This latter method of running a macro is convenient when EES is to be called from another program. Several major new capabilities for macros are:

1. A menu option has been added to the Windows menu to access the Macro window.
2. The SaveTable, SaveArrays, SaveLookup, and OpenLookup macro commands can specify the name of the table to open or save in a string variable (e.g., FN$) that is assigned either in an EES program or with an assignment statement within the macro file.
3. Macro files can contain assignment statements for EES variables that retain their values and can be used in the equation set when the SOLVE command is processed. This capability allows a series of solutions to be run with different values of one or more variables, similar to a Parametric Table. Call statements can also be issued from Macros.

Debugging EES Programs: S.A. Klein

As an instructor in several courses in which student use EES for homework problems, I am often asked to help students identify problems with their EES programs. This list below summarizes some of my debugging experiences.

Enter EES equations in small sections

I am continually surprised to find that users attempt to enter all of the equations needed to solve a problem at one time, before attempting to solve the problem. Although I am very

experienced in using EES, I seldom would do this. Instead, I enter a small set of equations and ensure that this set is solving properly and it is dimensionally correct before proceeding with the next set. I may also update the guess values after successfully solving each section. Users sometime tell me that "I could not solve this subsection because the value of X is not yet known." In this case, I would recommend entering a temporary equation that sets the value of X to a reasonable value. This equation can then be removed after the subsection is checked.

Enter units for all variables and check units

Most of the errors that I find are a result of unit problems. EES provides very powerful unit consistency checking capability. To use this capability, it is necessary to enter the units for each variable and then, to pay attention to the unit checking warnings. I generally will not look for other problems until I am convinced that there is not a unit conversion error.

Use the Residuals window

The most useful tool in debugging an EES program is the Residuals window. This window shows the blocking order of the equations. All equations in block 0 have only one unknown variable and they are solved one at a time in the order shown in the Residuals window. Equations in higher order blocks are solved simultaneously in an iterative scheme in which all of the equations in the block are involved. When an EES program fails to converge to a solution, you can generally see which block it was working on when the convergence failed. The variables that are determined with the equations in this block are shown in bold font. It is these equations and variables that are the source of the problem and deserving of more attention. A common cause of convergence failure is simply poor guess values or bounds for the variables in this block. Setting guesses and bounds with the Variable Information dialog may cure the problem. Alternative, it is sometimes an inappropriate lower or upper limit that causes the problem. Other common problems sources are described below.

Hidden redundancies

Consider the following three equations with three unknowns, P, h, and T

```
P=100 [kPa]
h=enthalpy(R134a,T=T, P=P)
T=temperature(R134a,h=h, P=P)
```

These equations may or may not result in a solution, but even if a solution is achieved, it will not be correct. The problem is that the second and third equations are really different ways of expressing the same relationship between h, T and P and they are not independent. It is often difficult to identify problems of this type, particularly when the equations are not physically close to one another within the EES program. Another cause of problems of this type is a redundant equation arising from an overall energy balance on a system. If you enter equations that conserve energy for every component in the system, it is redundant to also enter an energy balance on the overall system.

Saturation problems

Consider the following equations. They appear straightforward, but they will not solve.

```
P=100 [kPa]
h=1500 [kJ/kg]
h=enthalpy(Steam,T=T, P=P)
```

The problem here is that with this combination of P and h, the state is within the vapor dome. In this case, the temperature and pressure are not independent and therefore not solvable. In this case, simply replacing the last equation with

```
T=temperature(Steam,h=h,P=P)
```

eliminates this problem. Note that this problem can occur even if the actual state is not in the two- phase region since EES may assume it is two-phase in the course of iteratively trying to solve the equations.