

# EESy Solutions

Engineering Equation Solver Newsletter

No. 9, Spring 2000



## 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 registered users of EES. Did you miss any of the previous issues? These and other goodies can be downloaded from our new web site: [www.fchart.com](http://www.fchart.com).

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## Visit our Web Site ([www.fchart.com](http://www.fchart.com))

The new F-Chart Software website is easier to navigate and more attractive than its predecessor. In addition, a variety of useful items can be downloaded free such as the latest copy of the manual, new examples, external programs, and a demonstration copy of FEHT (our finite-element analysis program). For international users, there are a French and Spanish manual and example problems in German.

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## WCB/McGraw-Hill Academic License

New academic versions of EES are now exclusively distributed by WCB/McGraw-Hill. Academic versions of EES are provided at no cost to educational departments that adopt any of the following WCB/McGraw-Hill textbooks.

Cengel Y.A. and Boles M.A., *Thermodynamics: An Engineering Approach* 3<sup>rd</sup> ed., 1998, ISBN 0-07-011927-9

Cengel Y.A., *Heat Transfer: A Practical Approach*, 1998, ISBN 0-07-011505-2

Wark, K. and Richards, D.E., *Thermodynamics* 6<sup>th</sup> ed., 1999, ISBN 0-07-068305-0

White, F.M., *Fluid Mechanics*, 4<sup>th</sup> ed. 1999, ISBN 0-07-069716-7

Educational site licenses can also be obtained from WCB/McGraw-Hill independent of any textbook adoption. The McGraw-Hill EES web site provides additional information.

[www.mhhe.com/engcs/mech/ees/index.mhtml](http://www.mhhe.com/engcs/mech/ees/index.mhtml)

F-Chart Software continues to support and distribute the commercial and professional versions of EES.

## What's New?

The last official update for the Windows version of EES was in April 1999 with version 4.934. The current version is 5.164. There have been over 230 new versions developed during the last year. Many of the releases were for minor bug fixes but there have been some very significant enhancements to EES as well. One change is that EES now supports Windows 2000. Here is a short description of other important changes.

### High Accuracy Property Data

High accuracy thermodynamic property data have been implemented for carbon dioxide, methane, ethane, propane, isobutane, n-butane, neon, nitrogen, oxygen, helium, R22, R23, R32, R134a, ammonia, argon, and R152a. These high accuracy property data are based on a property correlation called the Fundamental Equation of State in which all properties are determined from one functional relationship so thermodynamic consistency is guaranteed. The NIST REFPROP 6 program also uses this equation of state for refrigerants. The major advantage of the high accuracy formulations is that they provide accurate property values at high pressures. These formulations retain high accuracy in the compressed liquid regime as well as at conditions near the critical point. The Martin-Hou property correlations provided in earlier versions of EES fail to provide accurate thermodynamic properties at these conditions. The Martin-Hou formulations will eventually be eliminated but they have been retained to provide backward compatibility. Transport property correlations have also been revised and their ranges have been extended for the fluids noted above. If you depend on the property database in EES, this change alone would make it worthwhile to update to the new version.

High accuracy thermodynamic properties of water are now provided in substance Steam IAPWS which implements the 1995 Formulation for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use, issued by The International Association for the Properties of Water and Steam (IAPWS). This capability is available only in the Professional version.



### Property Plot Enhancements

The capabilities of the Property Plot command in the Plot menu have been expanded. EES can now plot lines of additional thermodynamic variables on the each plot. The pressure-enthalpy plot, for example, can now include lines of constant temperature, entropy, and quality. The temperature-entropy plot can include lines of constant pressure, volume, and quality. As before, calculated state points can be overlaid on the property plots to clearly show the behavior of a thermodynamic cycle.

### New Property Functions

Property functions IsentropicIndex, Prandtl, and SurfaceTension which respectively provide the specific heat ratio, Prandtl number and surface tension for a fluid at specified conditions have been added to the built-in property data functions.

### Integral Table

A new directive called \$IntegralTable allows intermediate values of specified variables during numerical integration with equation-based Integral functions to be automatically placed in a table called the Integral Table. The values in the Integral Table can be plotted, printed, or copied, just like the data in the Parametric, Lookup or Arrays tables. This capability makes it much easier to solve differential equations. In particular, the Integral Table decouples the selection of the step size used for integration and the frequency of the reported data for use in plotting the trajectory of the dynamic variables. It is no longer necessary to set up a Parametric table to obtain intermediate integration results.

### Improved Integration Auto-step Algorithm

The automatic step size adjustment algorithm used in equation-based Integrals has been significantly improved. Computational effort can be as much as an order of magnitude lower for the same accuracy with the new algorithm, depending on the nature of the problem. The parameters which control the calculation effort and accuracy of integration can now be entered in the Tolerances dialog (Options menu), which replaces the former Stop Criteria dialog.

### Diagram Window Improvements

The capabilities of the Diagram window for the Professional version of EES have been greatly expanded. For example:

1. 'Hot areas' can be set in the Diagram Window which, when clicked, bring up a child Diagram window. Now 'hot areas' can be placed on child Diagram windows as well to create 'grandchildren'. Hot areas can be placed on these windows as well. Navigation buttons are provided on all child Diagram windows to allow easy access to any Diagram window. The Windows menu shows the Diagram windows in an outline hierarchy.
2. Link buttons can be placed on the Diagram window or child Diagram windows. The action taken by the Link button can be to start any Windows program, to open an EES file, to start an EES Macro, to open a selected file in an EES Distributable program, or to show any child Diagram window.
3. A Help button can be placed on the Diagram window or child Diagram window. When the user clicks the Help button, a help document will be displayed. You can design your help documents to be ASCII text files, Windows help files or HTML files. Fancy help files with animation can be created in this manner.
4. The Diagram windows now provide tools to draw colored lines, rectangles, and ovals. The graphic items can be moved, scaled, selected, and aligned in a manner very similar to that used in popular drawing programs. Background and foreground colors can be selected from a spectrum of 16 million colors. It is no longer necessary to import a drawing into the Diagram window, although that capability is still supported.
5. Perhaps the most powerful new capability for the Diagram Window is the ability to use a drop-down list in a Diagram Window to enter one or more EES equations. This is accomplished by following the string that is to be displayed with characters // and then with one or more EES equations. The user does not see the equations, but they are executed whenever the user selects the string variable. This new feature provides several



new capabilities. It allows one or more EES numerical variables to be specified when the user selects a string. It also allows inputs to a model to become outputs and vice versa.

- It is now possible to save a diagram input (.VAR) file with a specified file name using the Save button on the Diagram window. The toolbar allows a Load button to be placed on the main Diagram window. Clicking the Load button will open a specified .VAR file and update all of the inputs fields in the Diagram windows.

#### \$Export Directive

An \$EXPORT directive has been provided to allow selected variables to be written to an ASCII file in .TXT or .CSV formats. For example, the following line will create a file that can be directly read into a spread-sheet program with calculated values of X, Y, and Z

```
$EXPORT myfile.CSV, X,Y,Z
```

This directive simplifies the task of copying results to an EES Lookup file or to another applications.

#### Macro File Extensions for Microsoft Word

The Macro language recognized by EES with DDE (Dynamic Data Exchange) has been extended. Nearly all EES commands now have a macro file command. In addition, macro file commands have been added to control Microsoft Word directly from EES. For example, an EES macro file can open a selected EES file, then start Word, create a new file, solve the EES file, copy the Equations, Solutions and Plot windows to the Word file, save the Word File and close Word – all without any user intervention.

#### Miscellaneous Improvements

- ✓ You may not have known that there was a 64 kByte limit to the amount of text that could be entered into the Equations window. That limit has been raised to 128 kBytes.
- ✓ The 255-character limit for the maximum length of the lines EES processes has been removed for comments. It is now possible to enter long paragraphs of comments. The comments will automatically line break to fill the Equations window if the Wrap Long Lines

option in the Preferences Equations tab is selected. The Formatted Equations window will also line break the comments in the display window and in the printed output.

- ✓ String variables can now be used to specify the units of other variables. For example:

```
U$='kJ/kg'  
h=15 "[U$]"
```

- ✓ The comment to the right of the 15 sets the units of variable h to U\$. The units could also be set in the Variable Info dialog or by clicking on h in the Solution window. In any case, EES will recognize that U\$ is a string variable and set the units of h to the string that is assigned to U\$.

Appending \_hat to a variable name, e.g., F\_hat, places a ^ symbol above the name. \_star will display as superscript \* in the Solution and Formatted Equations windows. For example, T\_star will display as T\*.

- ✓ The contour plot algorithms now allow the plot resolution to be specified. The calculation speed has been increased by an order of magnitude
- ✓ The Lookup\$Row function has been implemented. The LOOKUP\$ROW function operates just like the LOOKUPROW function except that its final argument is a string rather than a value. The function returns the row in the table in which this string exists.
- ✓ The bitmap resolution and black&white/color setting of plots copied to the clipboard can now be set in the Preferences dialog/Plot tab. Using these preferences allows the quality of plots copied to other applications to be controlled. Pasting a plot as a Device Independent Bitmap provides the highest quality image but it requires more memory than pasting as a picture. When a plot is copied into a word processor application as a bitmap, it will print as it would have printed directly from EES.
- ✓ The Units.Txt file has been modified to accept  $\mu\text{m}$  as a length unit. To enter  $\mu\text{m}$ , hold the Alt-Key down and type 230 on the numeric keypad. Let the Alt key up and the  $\mu$  should appear. Then enter m. Other useful

characters are Alt-248 which displays the degree symbol ° and Alt-250 which appears as a dot (·) and is used to represent multiplication. The Convert routine in EES will accept a hyphen (-), a star (\*) or character 250 (·) as a separator for units. For example, W-hr, W\*hr and W·hr will all be accepted in the Convert command for Watt-hours.

- ✓ Right-clicking on Parametric, Lookup, Arrays, or Integral table will bring up a pop-up menu allowing the current selection to be cut, copied, or printed. This option provides a convenient way to print a specified section of a table. Right clicking in the first column can also set Borders and colored rows.
- ✓ Holding the Shift key down while creating or resizing lines/arrows on the Plot and Diagram windows will constrain the lines to be horizontal, vertical, or on a 45 degree angle. If the Shift key is depressed while creating or resizing rectangles or circles, the rectangle or circle will be drawn with equal height and width.
- ✓ Right-clicking the mouse on the Equations window now brings up a pop-up menu allowing the current selection to be commented, cut or copied. Access to the Variable Info dialog window is also provided.
- ✓ A temperature conversion function has been implemented. The ConvertTemp function has the following format: ConvertTemp('C', 'F', T). The first two parameters are string constants or string variables which must be C, K, F, or R, representing the Celsius, Kelvin, Fahrenheit, or Rankine scales. The third parameter is a temperature in the scale indicated by the first parameter. The function returns the temperature in the scale indicated by the second parameter. In the example above the function would return the temperature in °F corresponding to the temperature T in °C. The single quotes around the string constants are not required.
- ✓ The arrowhead size can now be changed on the Plot and Diagram windows. The arrowhead size is automatically scaled when the Plot or Diagram size is changed.
- ✓ A Data button has been added to the Modify Plot dialog. This button becomes active if the

Automatic Update option is enabled. When clicked, the Data button allows the source of the plotted data to be changed. It is possible to change the range of rows, the X and/or Y-axis columns and the table from which data are plotted. EES will automatically update the plot to reflect the change in the data source. The most common use for this capability is to change the range of rows that has been previously selected for a plot line.

- ✓ Text and objects on the Diagram windows can now be selected using a selection rectangle, as in most drawing programs.
- ✓ The Viscosity and Conductivity functions now allow any set of independent properties as inputs rather than just temperature and pressure.
- ✓ The Make Distributable dialog window now has buttons to save and load scripting information. The save button copies all information in the Make Distributable dialog window to a file having an .MDI filename extension. The load button allows an .MDI file to be opened so that the information in the file can be used to fill the fields in the Make Distributable dialog window. (This capability is available only in the Professional version.)

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### ***Professional Version***

The Professional version of EES was formally released in June 1998. The Professional version of EES provides a number of capabilities in addition to those provided by the Commercial version: In particular, the Professional version supports macros, greatly expanded capabilities on the Diagram window including child diagrams, hot links to other applications or EES files, and the ability to create Distributable EES programs. Distributable programs are special purpose versions of EES that will run one to five pre-selected problems. They can be freely distributed to others so users of your EES programs not need to own EES to run the calculations or to create/ change/view the plots and tables. The Professional version allows up to 10,000 equations and tables of unlimited size.