

# EESy Solutions

## Engineering Equation Solver Newsletter

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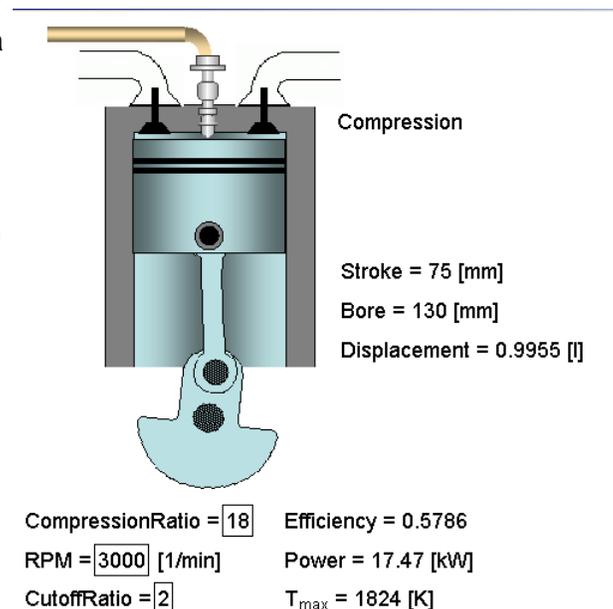
### Welcome

This is the 35<sup>th</sup> issue of EESy Solutions, a newsletter that provides news, tips, and other updates for users of the Engineering Equation Solver software. This issue discusses some features of the Diagram Window, including a new feature that allows a user to enter inputs as equations.

EES has been commercially available for more than two decades. If you have missed any of the previous issues of EESy Solutions, they can be downloaded from [www.fchart.com](http://www.fchart.com).

### The Diagram Window

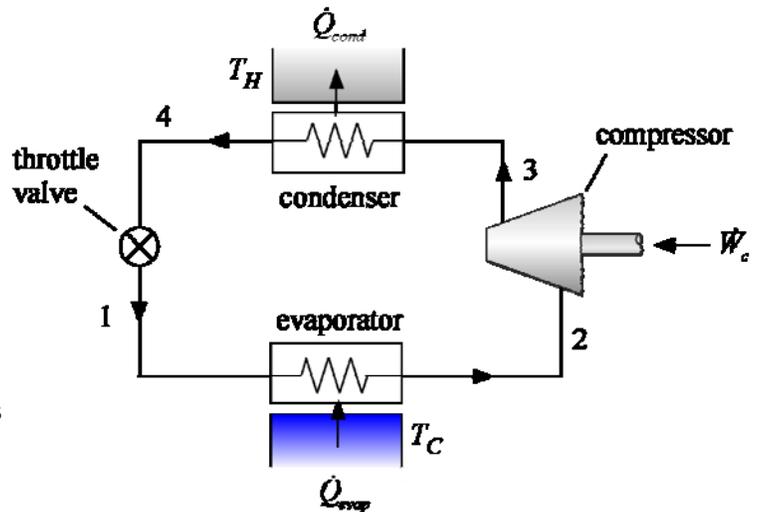
The Diagram Window provides the capability to provide a user-friendly, graphical interface to an EES program. The Diagram Window displays a schematic or graphic that clarifies the interaction between the user and the program. With little effort, text can be placed anywhere on the Diagram Window to display calculated information from the EES program. Inputs to the calculations can also be entered directly in the Diagram Window, instead of using equations in the Equations Window. Calculations, animations, and other operations can be initiated and controlled from the Diagram Window using buttons. The Diagram Window is the key to creating high quality engineering tools with EES that can be easily used by a wide variety of people. These tools are often made available as distributable programs that can be disseminated to users as executable files and run on computers that do not have EES installed; in these applications the Diagram Window provides the method by which users interact with the program. The Diagram Window is also the first step towards more advanced programs that employ animation (i.e., moving objects around to graphically represent the result of dynamic simulations).



## The Diagram Window (continued)

Consider a vapor compression refrigeration cycle shown in the figure. The refrigerant, evaporating temperature, condensing temperature, and compressor efficiency are all inputs. This program assumes no superheat or sub-cooling and no pressure losses in the evaporator and condenser.

The EES program that solves this problem and calculates the Coefficient of Performance (COP) of the cycle using the RealThermoProps function (discussed in EESy Solutions Vol. 34) is shown below.



```
$UnitSystem SI Mass kJ C kPa
```

```
T_cond=30 [C]   "condensing temperature"
T_evap=-5 [C]  "evaporating temperature"
F$='R410a'     "refrigerant"
eta_c=0.65 [-] "compressor efficiency"
```

"Evaporator outlet"

```
T[2]=T_evap; x[2]=1
```

```
Call RealThermoProps(F$, T=T[2], x=x[2]: , P[2], v[2], h[2], s[2], , )
```

"Condenser outlet"

```
T[4]=T_cond; x[4]=0
```

```
Call RealThermoProps(F$, T=T[4], x=x[4]: , P[4], v[4], h[4], s[4], , )
```

"Compressor outlet"

```
P[3]=P[4]
```

```
s_3s=s[2]
```

```
h_3s=Enthalpy(F$, P=P[3], s=s_3s)
```

```
h[3]=h[2]+(h_3s-h[2])/eta_c
```

```
Call RealThermoProps(F$, h=h[3], P=P[3]: T[3], , v[3], h[3], s[3], , )
```

"Valve outlet"

```
P[1]=P[2]; h[1]=h[4]
```

```
Call RealThermoProps(F$, P=P[1], h=h[1]: T[1], , v[1], , s[1], , x[1])
```

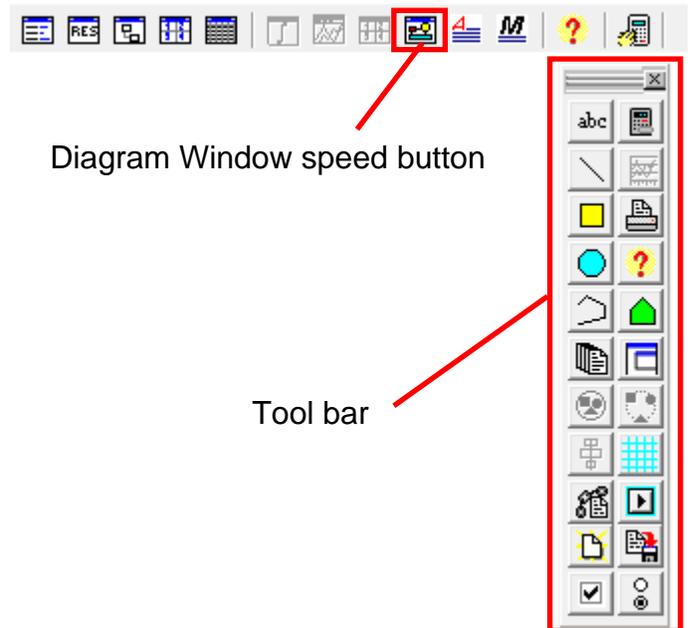
```
COP=(h[2]-h[1])/(h[3]-h[2])   "Coefficient of Performance"
```

Once the program is checked and its operation verified, you might want to develop an interface that allows a user to easily interact with the program by changing inputs and examining the resulting outputs

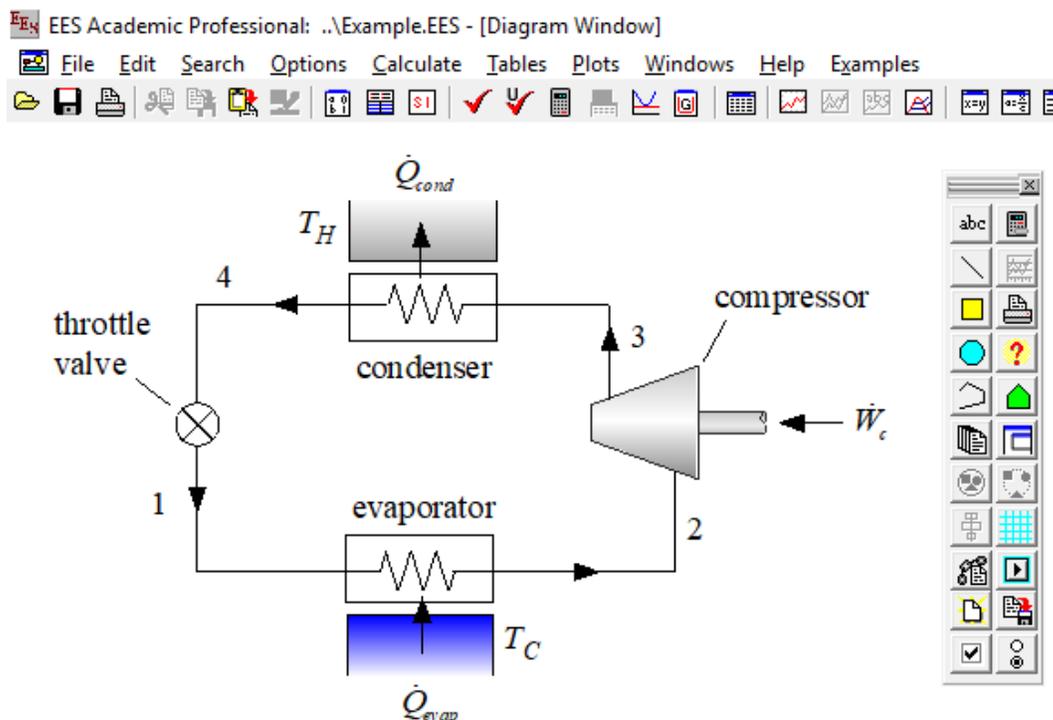
## Creating a Diagram Window Interface

The Diagram Window can be accessed either from the Windows menu or using the short-cut, Ctrl-D. The Diagram Window operates in two different modes that are referred to as the **development** and **application** modes.

When the tool bar is visible, the Diagram window is in development mode. Development mode allows you to edit the Diagram Window – adding objects, inputs, outputs, etc. Application mode allows the user to run the EES program using the Diagram window. The mode can be changed by selecting the Show/Hide Diagram Tool Bar command from the Options menu or by clicking the Diagram Window speed button that appears on the speed bar or by using the hot key Ctrl-D.



We can place a graphical picture of the refrigeration cycle onto the Diagram Window. One method to do this is to create an object using any drawing program (for example Canvas or Power Point) and then copy the item(s) to the clipboard. Return to EES and use the Paste command in EES to place the object(s) into the Diagram Window while it is development mode. The object can then be dragged to any location on the Diagram window and resized. Alternatively, the picture may be created using the drawing tools provided on the Tool bar and the pictures in the Diagram Window drawing palette.



## Adding Inputs & Outputs

Four types of text items can be placed on a Diagram window – all are placed using the Add text button in the toolbar. The four types of text are: plain text, formatted text, EES input variables, and EES output variables. Plain text is used for simple text items, such as labels. Formatted text (provided in the Professional version) consists of longer passages of text with format attributes such as subscripts, style, font variations, embedded graphics and ‘live’ EES variables that can display the current values of EES variables. Formatted text can be pasted directly from a word processor.

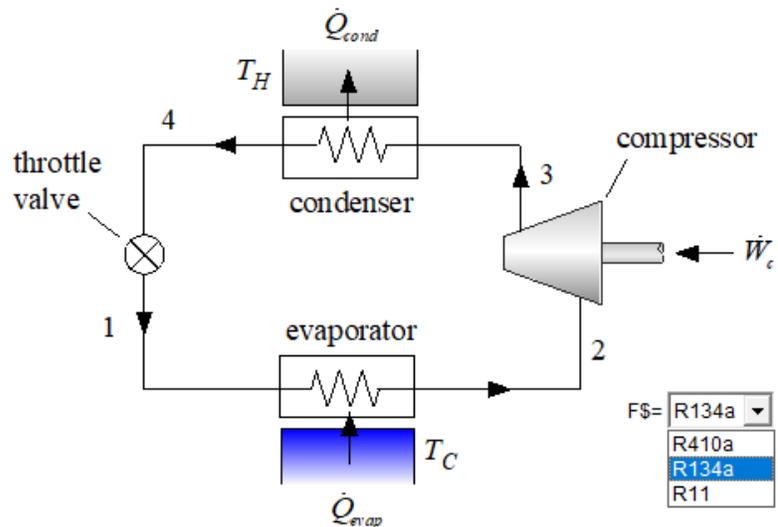
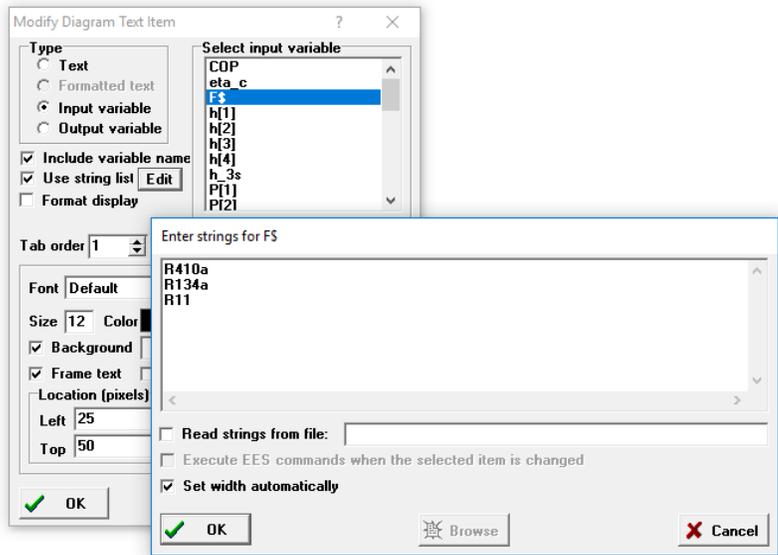
Input variables allow the user to control the program. Normally, the values of EES variables are entered with equations in the Equations Window. However, the Diagram Window offers an alternative way to enter EES variables and this provides the basis of a graphical user interface. Both numerical and string variables can be entered in the Diagram window. For example, F\$ is a string that contains the name of the refrigerant. If a string variable is selected to be an Input variable, then EES will provide the option of selecting the variable from a pull-down list of string constants that you provide.

Now the user can select the value of F\$ from a pull down list on the Diagram window. Put the Diagram window into application mode and hit solve and you will get an error saying that you cannot both specify F\$ from the Equations Window and the Diagram Window. Comment out the value previously set in the Equations window and you can now select the value of the fluid from the Diagram window.

We can continue by adding some numerical inputs. The values of the condensing and evaporating temperatures can be set by adding additional input items. We can place an outlet variable on the Diagram Window to show the calculated COP.

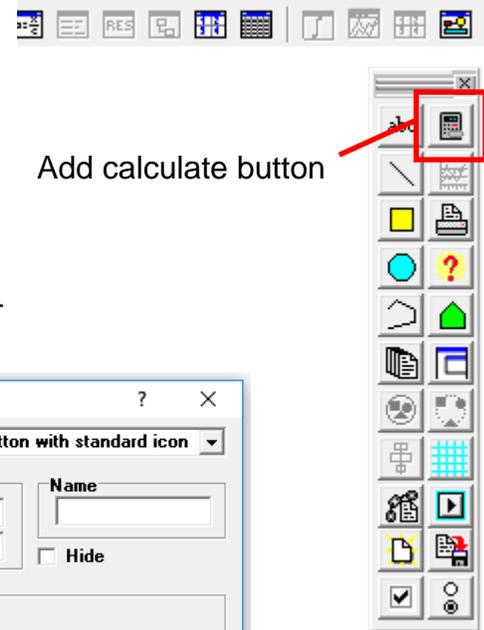


Add text toolbar



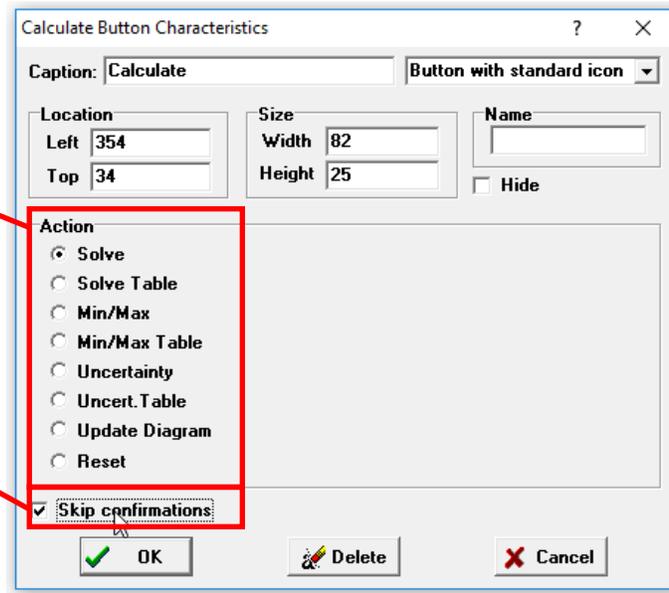
## Calculate Button

Finally we can add a Calculate button on the Diagram window that initiates calculations. This can be done by clicking the Add calculation button on the Diagram window tool bar. Then right-click on the button to access its properties



Add calculate button

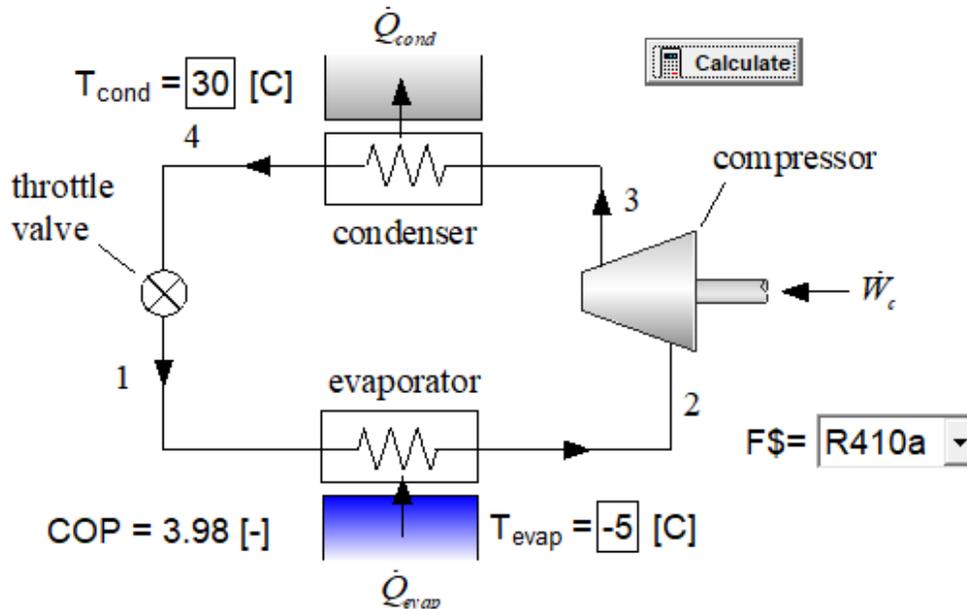
The action that the Calculate button initiates when it is pressed in application mode is specified by selecting one of the radio button options. Normally, EES displays a dialog before it starts the calculations, such as solving a Parametric table or doing an optimization. Checking the Skip confirmation button will suppress the appearance of the dialog.



Actions that can be initiated using the Calculate button

Skip confirmations

The result is a high quality user-interface for the program.

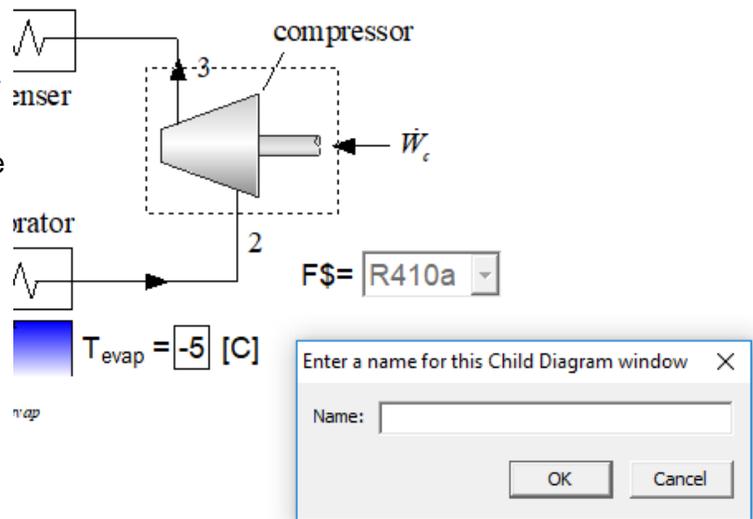


## Child Diagram Window

There are number of additional capabilities that can be added to the Diagram Window but one of the most important are Child Diagram Windows, which are available in the Professional Version of EES. Child Diagram Windows are additional Diagram Windows that can be opened from a “parent” Diagram Window in order to allow additional screens for inputs/outputs and provide a method of further organizing your graphical user interface.

The most straightforward method of creating a Child Diagram Window is to designate a “hot” area on the parent window that, when clicked, allows access to the Child Diagram Window. For example, let’s create a Child Diagram Window in our example that allows the user to enter the efficiency of the compressor. To create the Child Diagram window, press and hold the Shift and Ctrl keys down simultaneously while using the mouse with the left button depressed to outline a rectangular area (i.e., the “hot area”). We will create a hot area around the compressor.

When you release the mouse button, a small dialog window will appear where you must enter a name for the hot area. Click the OK button and an empty Child Diagram Window having the name that you entered in the dialog will appear. Note that each Child Diagram Window has its own tool bar and all of the capabilities of the main Diagram Window. You can enter any information or objects that you wish in this window, including graphics, text, and EES variable inputs and outputs.



In order to modify the properties of the Child Diagram Window, right-click the mouse anywhere in the Child Diagram Window, but not on an existing object or text. A small popup menu will appear. Select Properties to bring up the Modify Hot Area Dialog

Include navigation buttons

Include access tabs

The 'Modify Hot Area Information' dialog box is shown. It has the following fields and options:

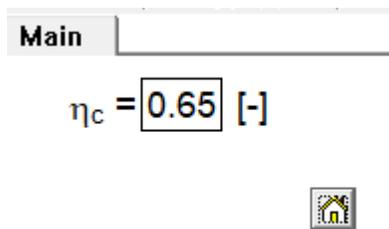
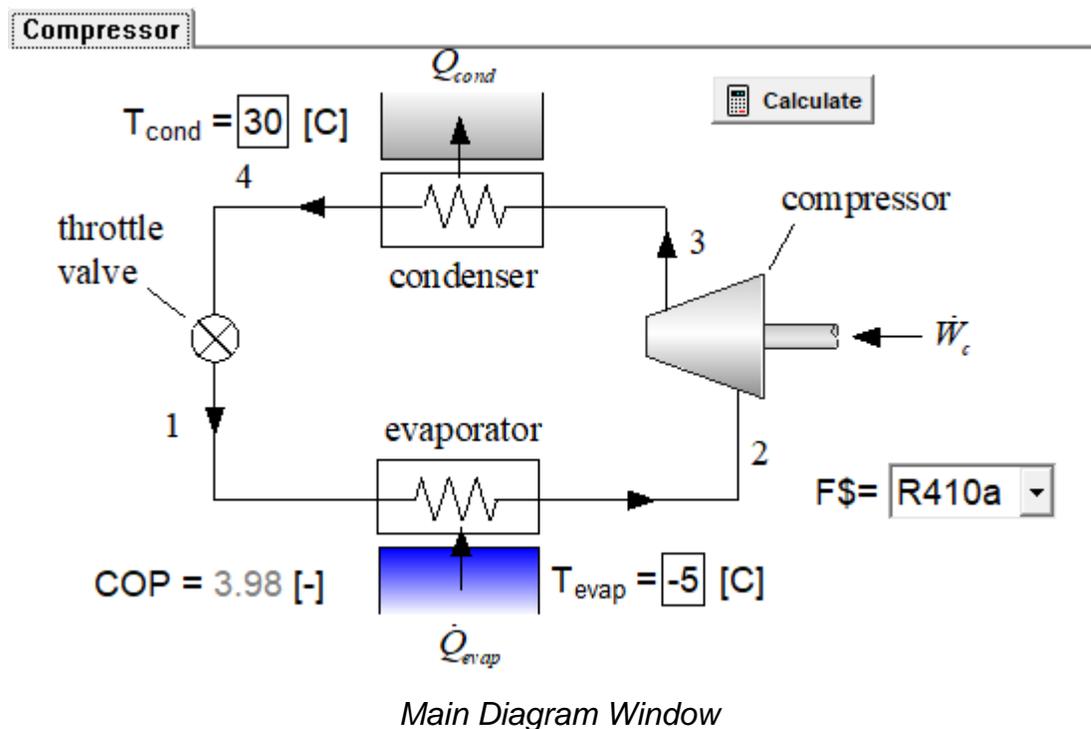
- Name: Compressor
- Accessed from: Main Diagram Window
- Location: Left 312, Top 118
- Size: Width 116, Height 88
- Enabled
- Include navigation buttons
- Show tab for access from Main Diagram window
- Include access tabs in this window

Buttons: OK, Delete, Cancel

## Child Diagram Window (continued)

The Include navigation buttons check box will, if checked, place optional navigation buttons at the lower right corner of the window. A small “go home” navigation button is initially placed in the lower right corner of the Child Diagram window. Clicking this button will close the Child Diagram Window and bring up the main Diagram Window. The location and size of these navigation buttons can be changed. A caption can be added to either button by right-clicking on the button while it is in development mode.

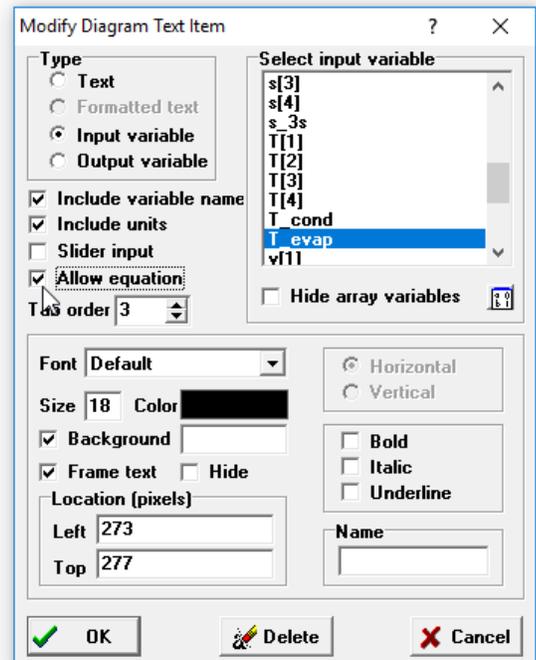
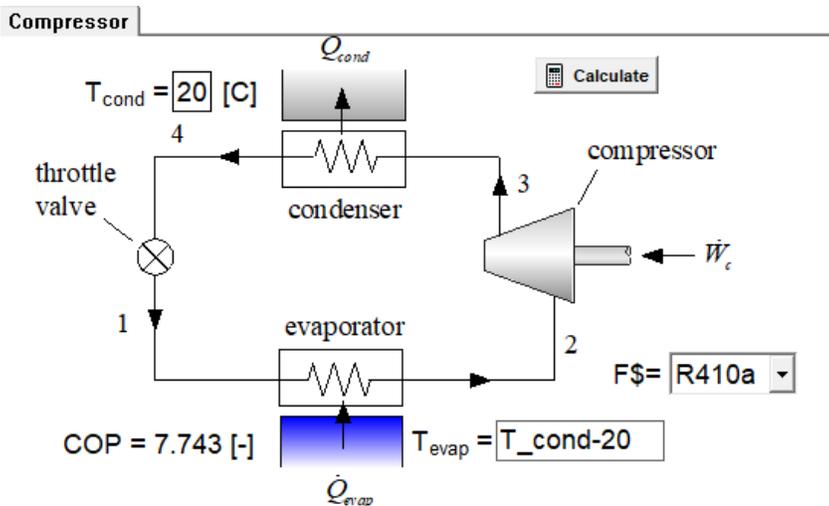
Selecting Show tab for access from the Main Diagram Window will provide a tab in all Diagram Windows that are designated to have tab controls. The tabs appear at the top of the Diagram Window and allow access across the various Diagram Windows.



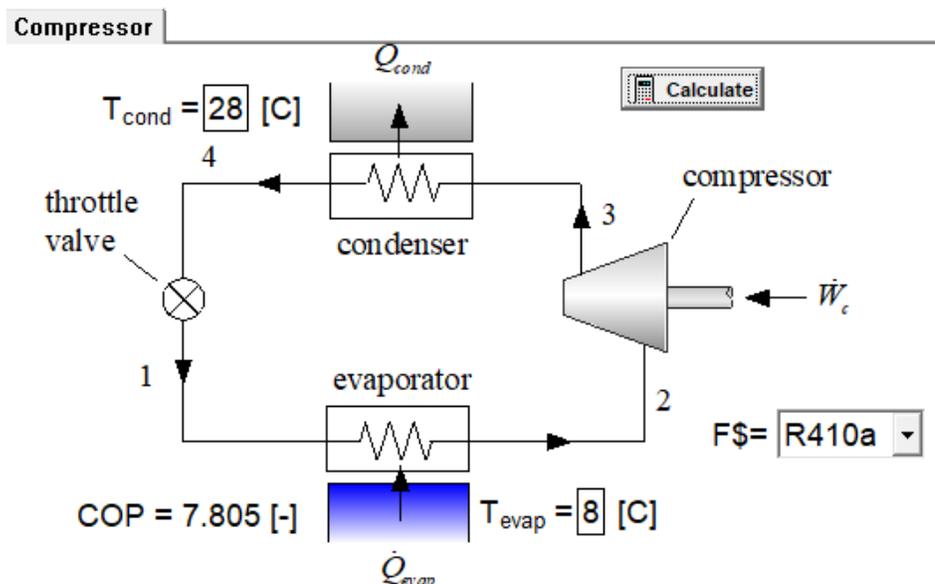
## Entering Inputs with Equations

It is possible to enter inputs into the Diagram Window using equations involving any of the functions or variables in the EES program. In order to demonstrate this capability, select the input corresponding to the evaporating temperature and right-click on the text box and select properties. Then select Allow equation. Return the Diagram window to Application mode.

Now it is possible to enter the value of the evaporating temperature either as a numerical input (as usual) or using an equation. For example, we can specify that the evaporating temperature must always be 20°C less than the condensing temperature by clicking on the input and entering  $T_{\text{evap}} = T_{\text{cond}} - 20$ .



You should see that whatever you enter as the condensing temperature, the evaporating temperature will always be set to 20°C lower once the Calculate button is activated.



## Recent Changes to EES

- The Calculate button includes a Reset option that resets the random number generator seed so that values returned by the functions Random and RandG are changed when they are next used. Also any equations used to provide inputs to the Diagram Window are reset to 1.
- The Random and RandG functions accept an optional third parameter that is used as a seed if positive. If a negative number is provided then the random number remains constant as long as the file is open. This capability together with the Reset option allows EES to be used to make 'quiz-type' problems. See the fin\_Exam.EES example in the Examples menu.
- The Allow Equations feature in the Diagram Window allows Input values to be set using equations
- Thermodynamic and transport properties for R454B, R515A, and siloxane MD2M have been implemented. Properties of HF7100 are improved. Thermodynamic properties for R1224yd(Z) have been added.
- The EXCEL.Cell macro command will accept either text or an EES numerical or string variable.
- The ChangeFileDir\$ function provides an easy way to change the directory name for a specified file.
- The ClearClipboard, DeleLookupCol, UpdatePlot, DeleteLookupRows, and DeleteParametricRuns macro commands have been added.
- Vapor pressure data are now provided for many of the brine fluids with the Pressure function.
- The \$UpdateGuesses directive will cause the guess values in the program unit that it is located to be updated after successful calculations are complete. The /A option causes this for all subprograms as well.
- Temperature-density plots are now available as an additional Property Plot.
- Right-clicking a variable in the Variable Information Palette to the right of the Equations Window will find that variable within the selected program unit (similar to the action of the Find command).



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### Instant Update Service

EES uses a different model for updating than most other programs. Each time that 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 of EES is placed on our website. Although the program has become very robust and stable, there have been many new versions of EES released since the last EESy Solutions was distributed.

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 the current cost of the program per year if renewed within 12 months after expiration of the Service. Contact F-Chart Software if you wish to re-subscribe to the Instant Update Service.