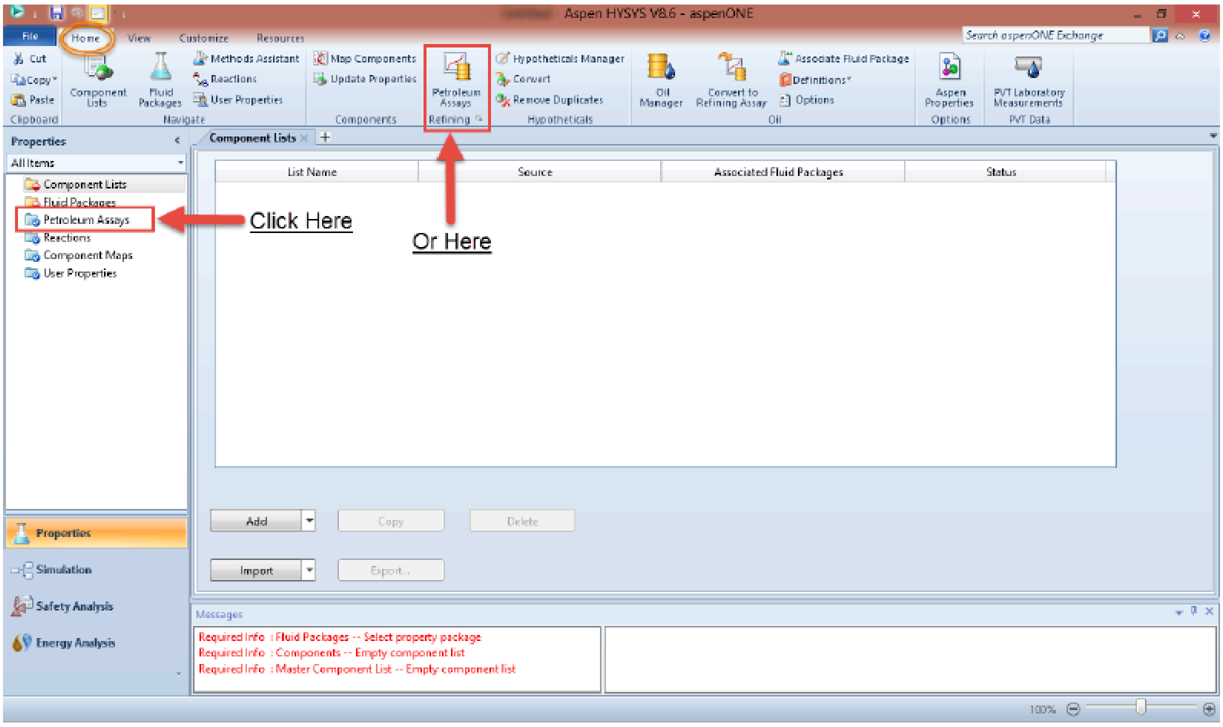
Petroleum Assays

➢ Petroleum Assay Management:-

The new Assay Management features in Aspen HYSYS Petroleum Refining allow users to use the same assays in Aspen HYSYS Petroleum Refining and Aspen PIMS, get better results for crude modeling using the improved characterization and property calculations of Aspen Assay Management, and access an extensive database of crudes and crude properties with the new assay library, and easily import data from other sources.

To use the Petroleum Assay Management we need to access the "Petroleum Assays" in the Properties Environment by:

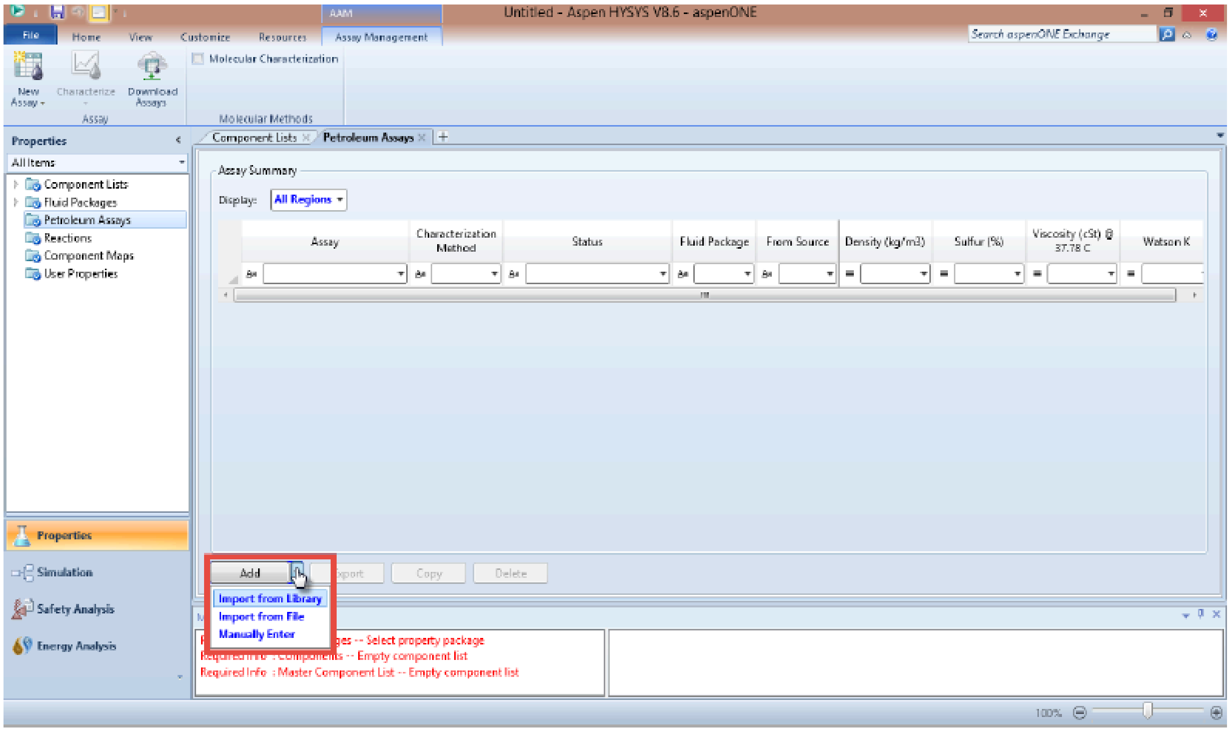
- Click "Petroleum Assays" in "Home" tab in the Ribbon.
- Click "Petroleum Assays" in the navigation pane.



1. Adding a New Assay:-

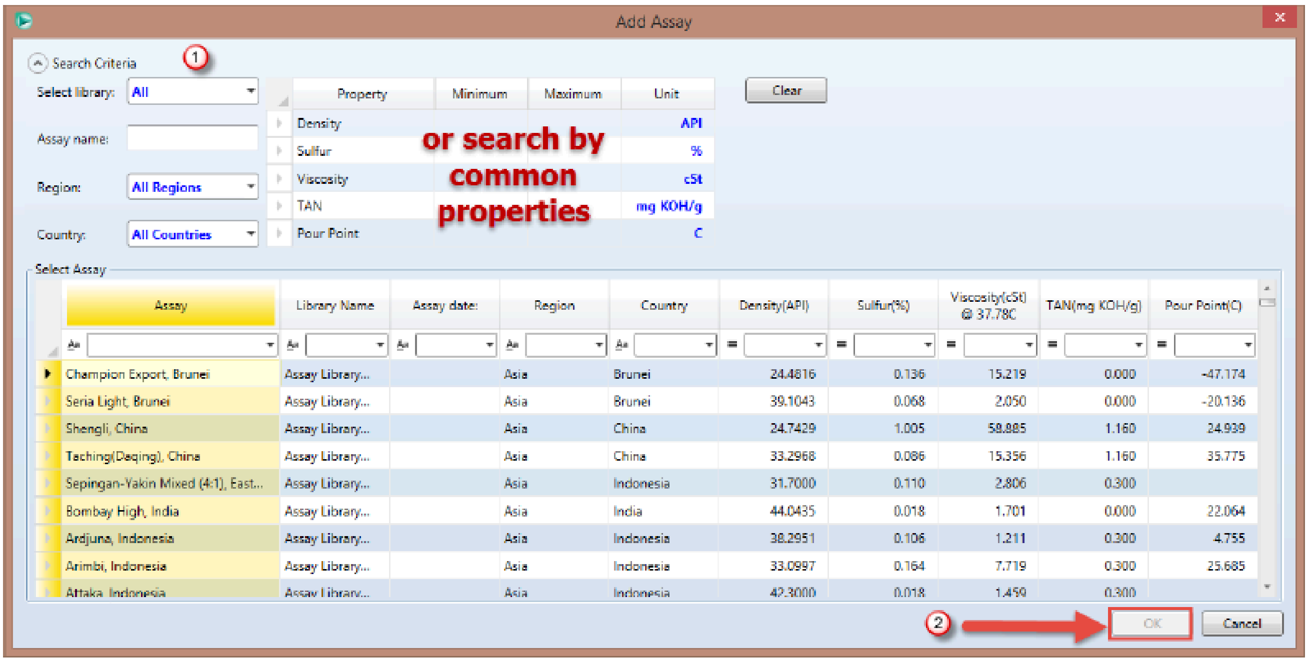
Under Petroleum Assays, you can add a new Assay by clicking the dropdown arrow and select one of the three methods available:

- Import from Library: Select an assay from the Assay Library.
- Import from File: Import a supported Excel, CSV, or .AFAM case with assay data.
- Manually Enter: Manually enter data into the Assay Table.

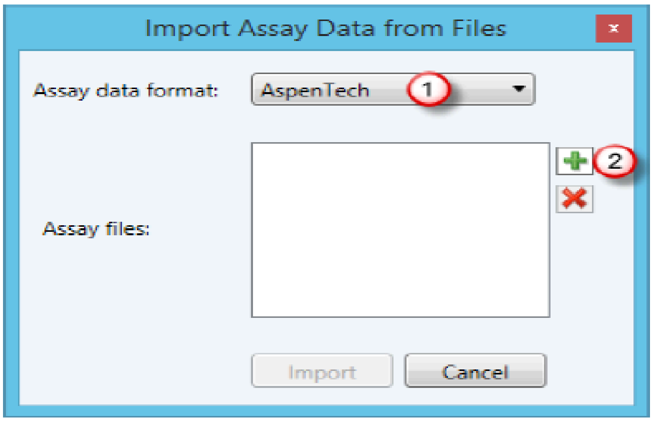


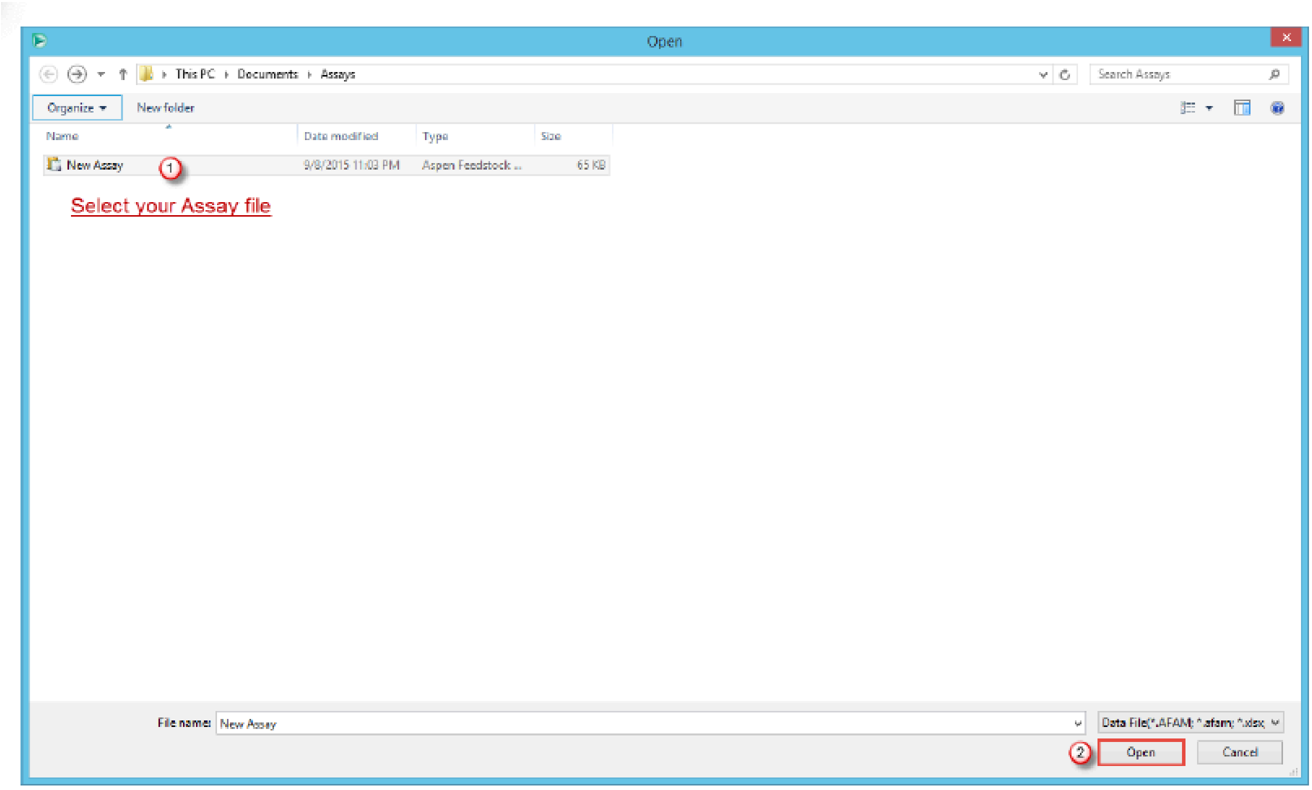
1.1. Import from Library:

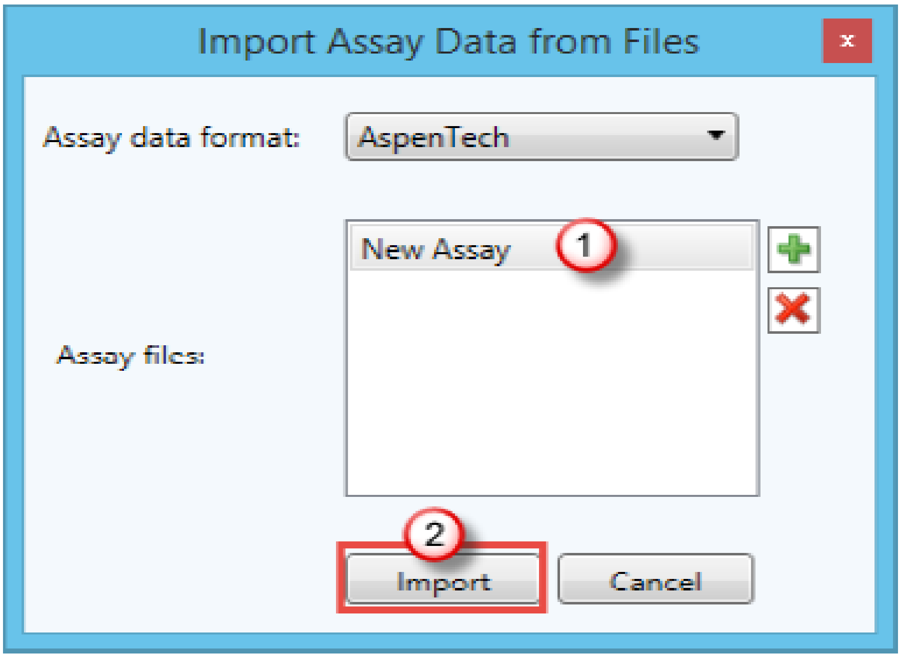
You can add pre-characterized assays from the HYSYS Petroleum Refining assay libraries.



1.2. Import from File:







1.3. MANUALLY ENTER:

By choosing "manually enter", the New Assay dialog box appears where you enter a name for the new assay in the New Assay dialog box, and select a Fluid Package to apply to the assay. You can pick one from the list or click <Create New> to create a new one.

Note: If no fluid packages have been created for the new assay, HYSYS automatically creates and attaches a preset petroleum fluid package to the assay with default components and hypotheticals. This applies to all options to create a new assay unless you import a .CSV file or a third party assay.

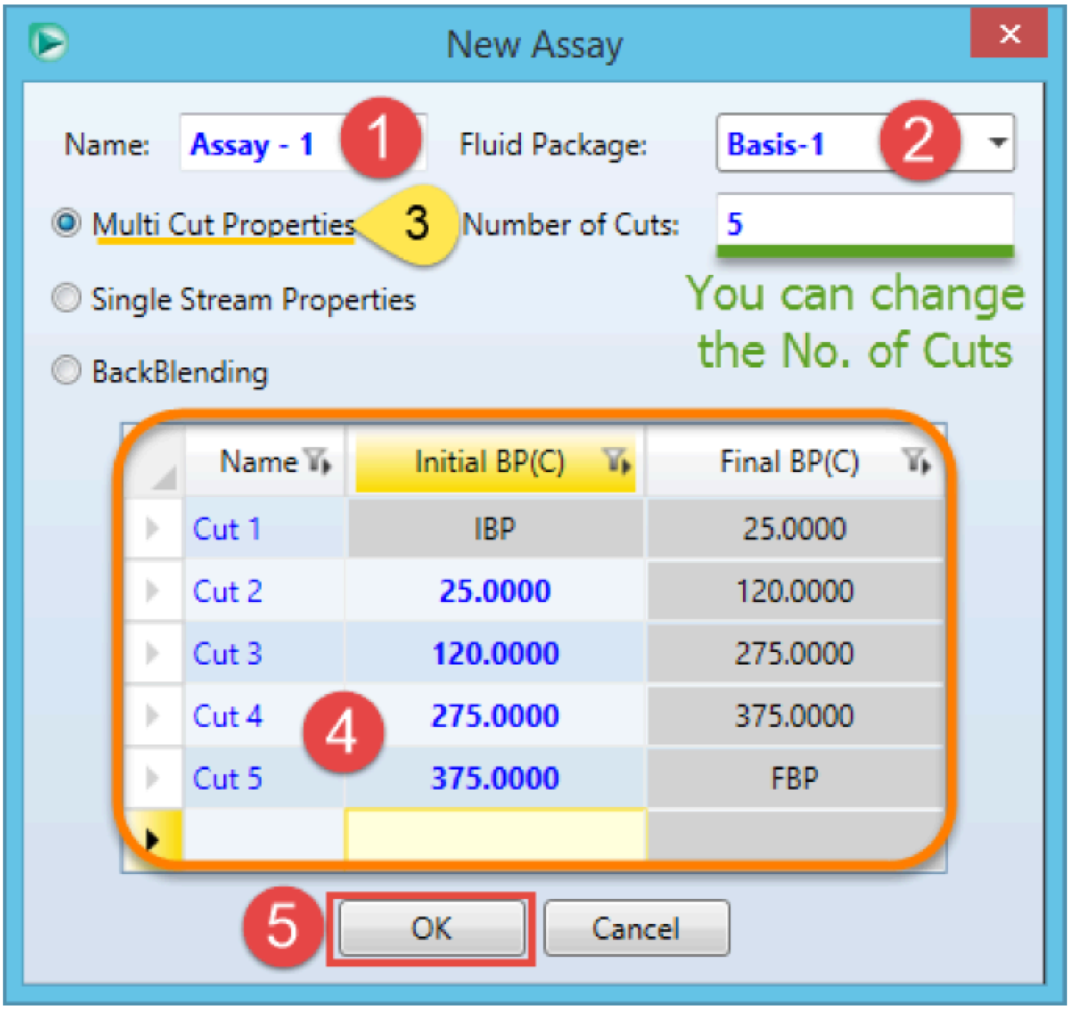
Then, Select the assay type: **Multi Cut Properties**, **Single Stream Properties**, or **Back Blending**.

1.3.1. MULTI CUT PROPERTIES:

Multi Cut Properties - lets you enter cuts with their initial and final boiling points.

This is ideal if you have data for specific assay cuts that you wish to enter, such as Cut Yields.

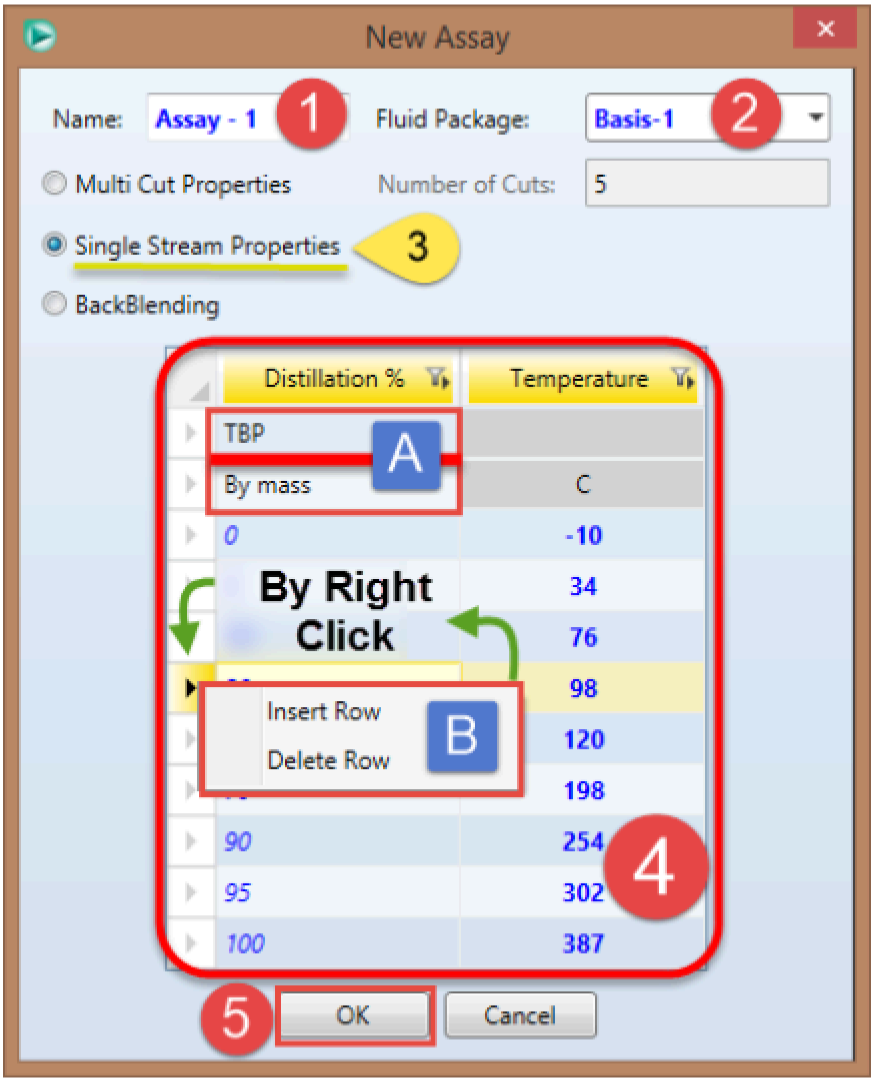
Here, you can set the number of cuts from your data and enter the boiling point ranges in the table provided.



1.3.2. <u>SINGLE STREAM PROPERTIES:</u>

Single Stream - lets you define the distillation percent and temperature of individual streams.

This option is ideal if you want to evaluate an assay from distillation data and bulk (whole crude) properties to create a single-stream for your model.



A. In the Curve type row, specify the method used for distillation: TBP, D86, D2887 or D1160.

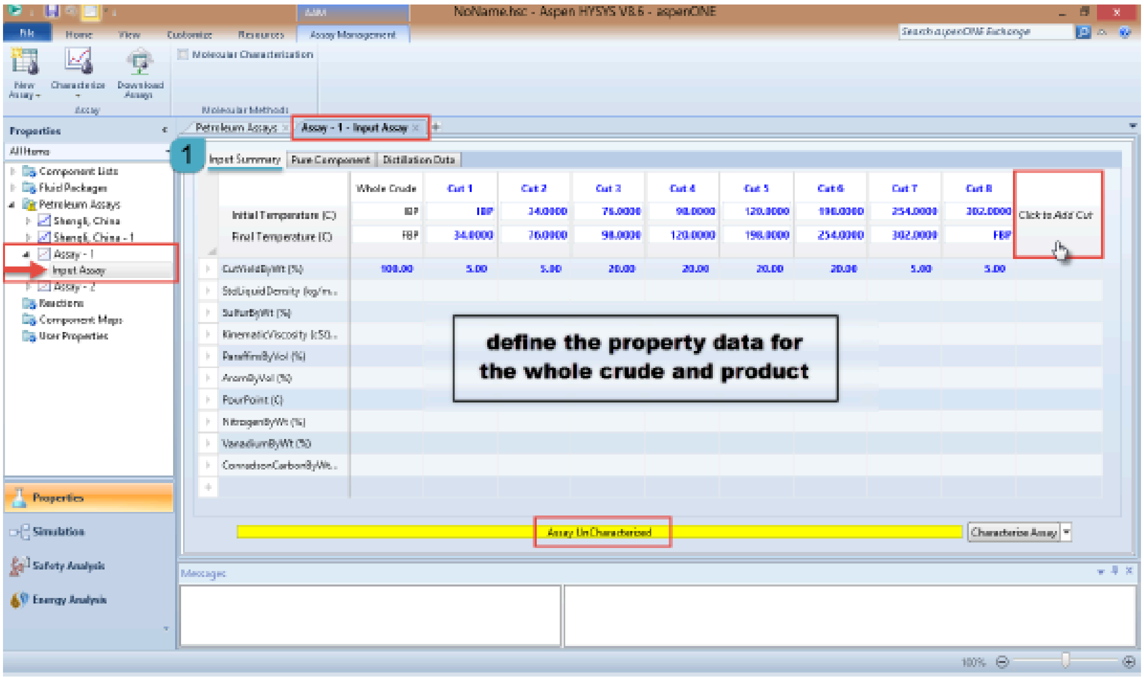
- Specify the Basis: By mass or By volume.

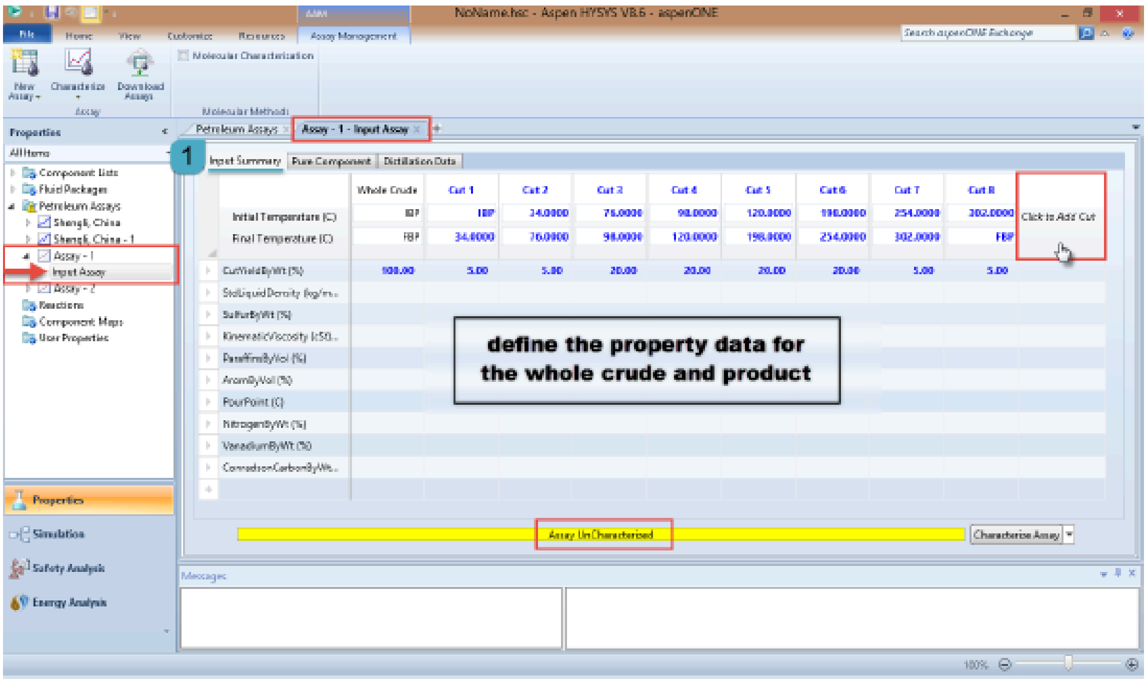
B. You can adjust the number of distillation Points by adding or removing Point.

After Adding the Assay Data Either with Multi-Cut or Single Stream, The "Input Assay" Form Displays …

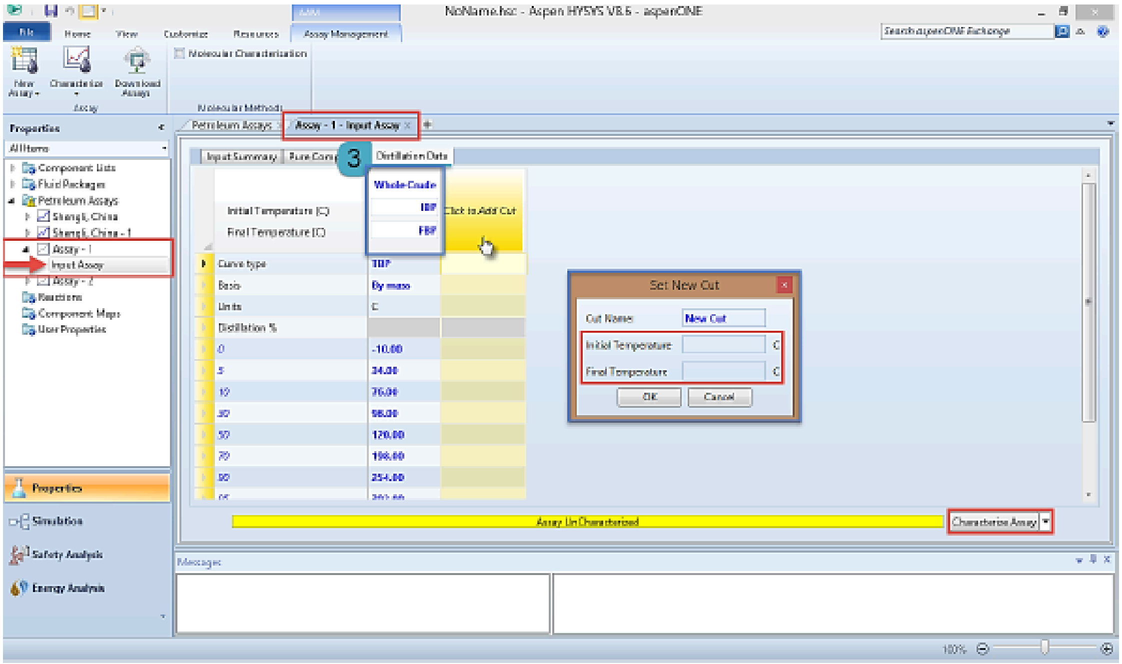
Use the **Input Assay** form to enter available experimental assay data including properties, pure components composition, and distillation data for different product cuts.

- **Input Summary** tab
  Display property data for the whole crude and product cuts.


NoName.hsc - Aspen HYSYS V8.6 - aspenONE
Assay Management
Petroleum Assays
Assay - 1 - Input Assay
1
Input Summary
Pure Component
Distillation Data
Whole Crude
Cut 1
Cut 2
Cut 3
Cut 4
Cut 5
Cut 6
Cut 7
Cut 8
Click to Add Cut
Initial Temperature (C)
Final Temperature (C)
CutYieldByWt (%)
define the property data for
the whole crude and product
Assay UnCharacterised
Characterise Assay

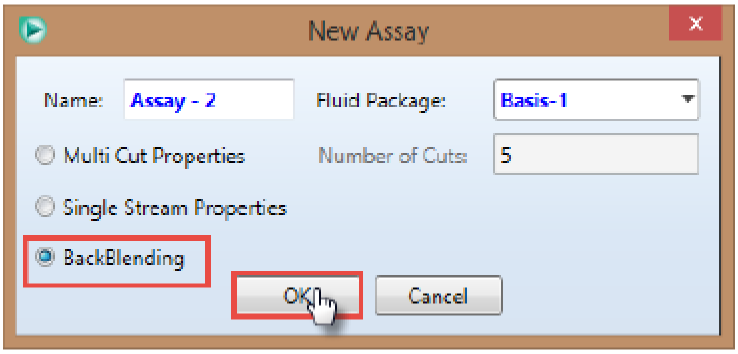

NoName.hsc - Aspen HYSYS V8.6 - aspenONE
Assay Management
Petroleum Assays
Assay - 1 - Input Assay
1
Input Summary
Pure Component
Distillation Data
Whole Crude
Cut 1
Cut 2
Cut 3
Cut 4
Cut 5
Cut 6
Cut 7
Cut 8
Click to Add Cut
Initial Temperature (C)
Final Temperature (C)
CutYieldByWt (%)
define the property data for
the whole crude and product
Assay UnCharacterised
Characterise Assay

- **Distillation Data** tab
  Display distillation data, such as TBP or D86 curve, of the whole crude or any product cuts.

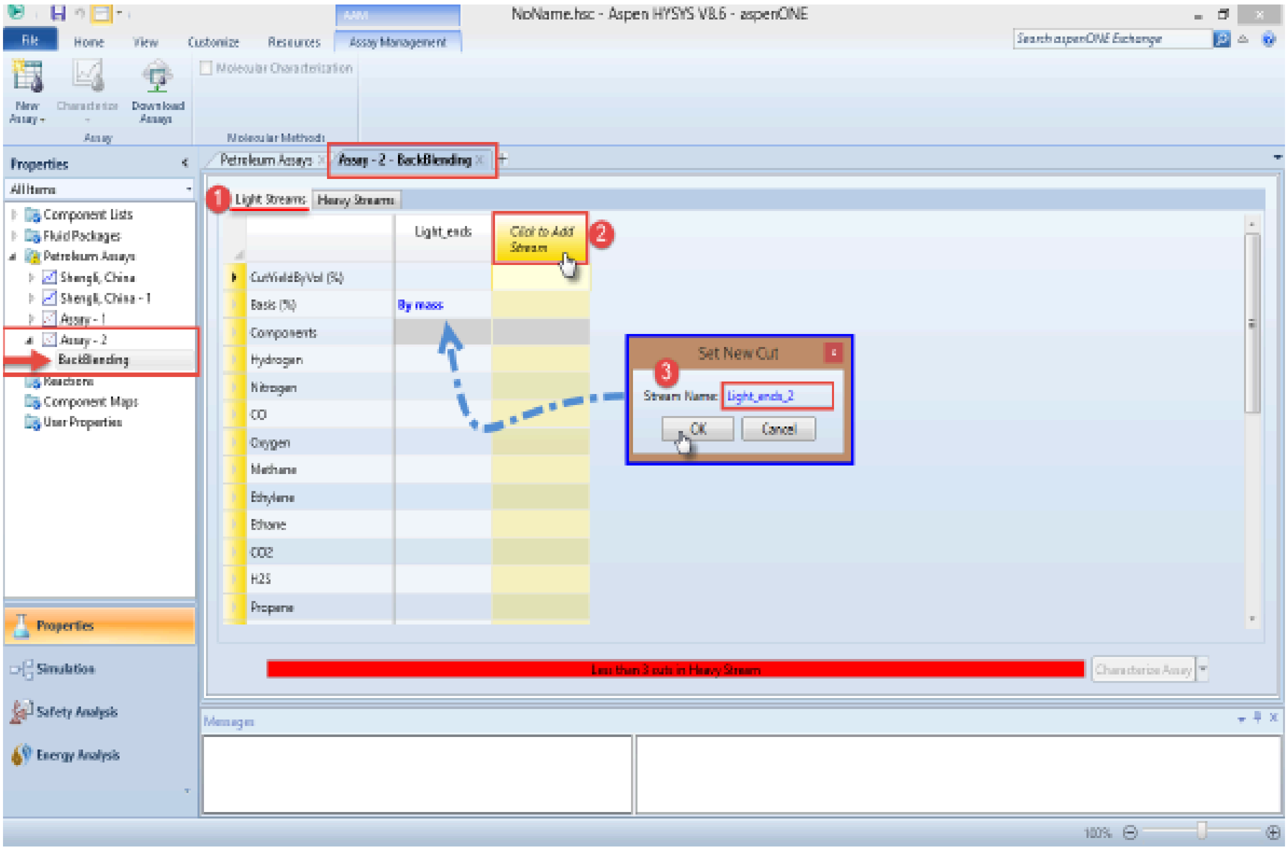


1.3.3. Back Blending:

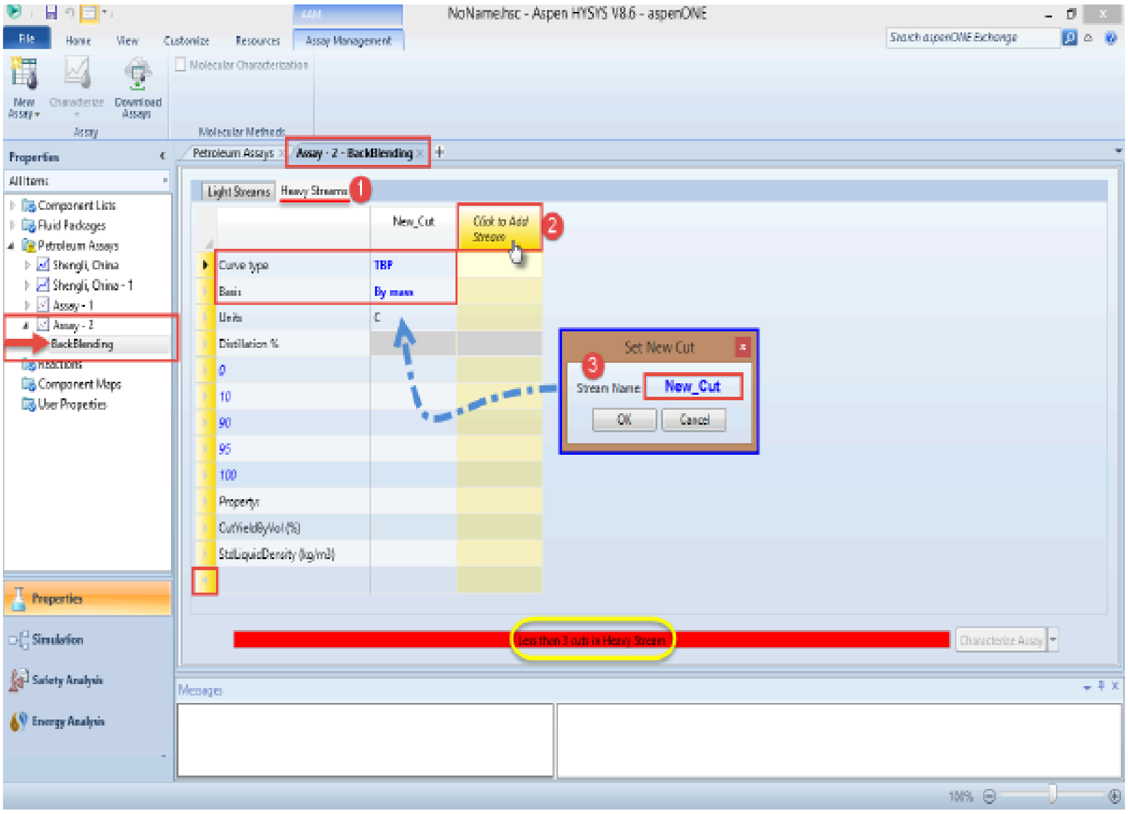
Back blending - lets you define feed streams by blending their associated products. The input products are typically defined in commercial distillations that have significant overlap across products. Backblending creates an assay from these overlapping measurements that can be used as a HYSYS Petroleum Refining feed stream.



After selecting Backblending, the Backblending Input Form appears on the navigation pane instead of the Input Assay Form.



- **Light Streams tab**
  Enter the component percentage for each assay and the cut yield of the total blend of each cut. The percentage of the same component on the light streams form and the heavy stream form should add up to 100%; if not, the value need to be normalized.



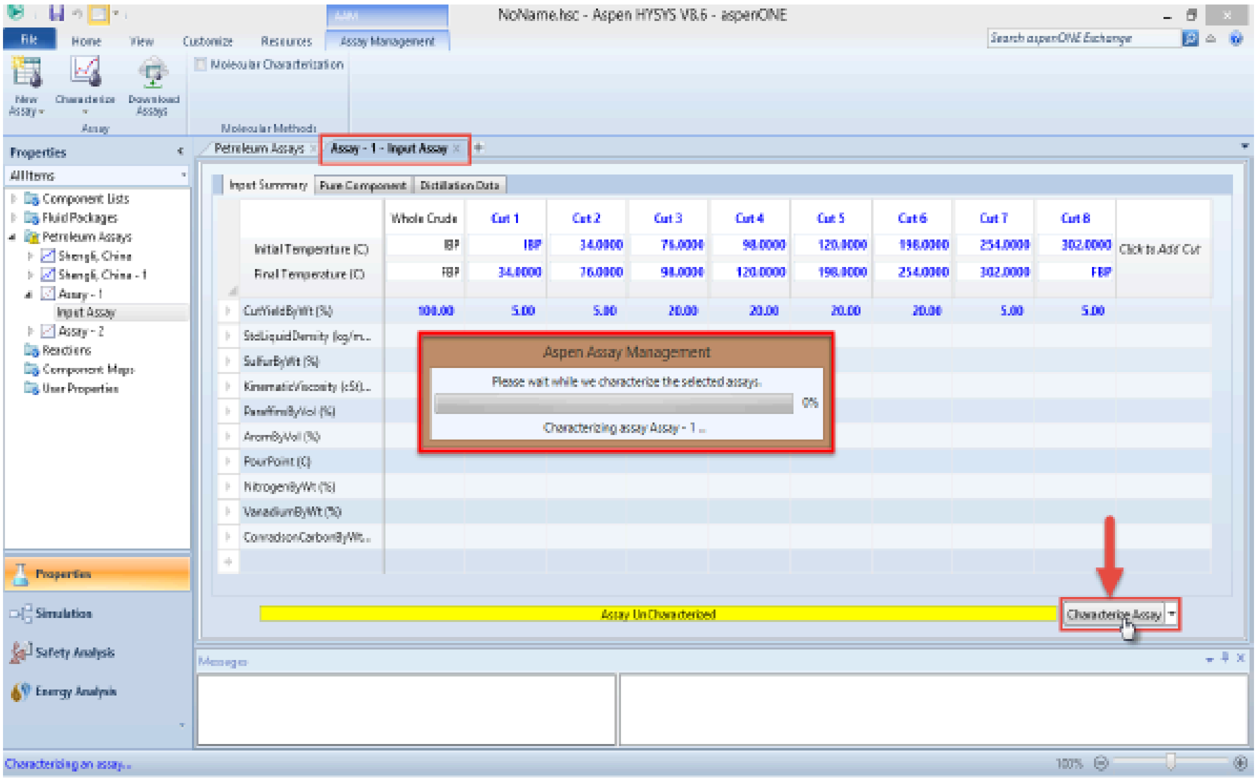
- **Heavy Streams tab**
  Enter the distillation yield and property data for each cut.

<u>**Notes:**</u>

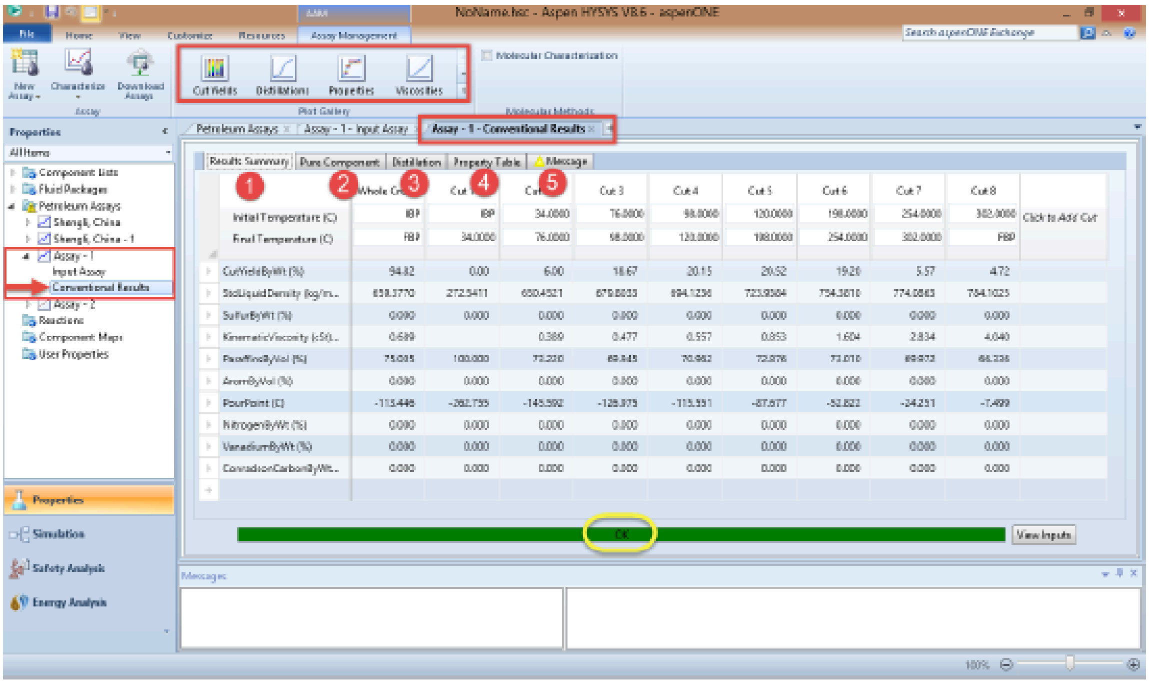
- At least 3 cuts in Heavy Stream are needed.
- In the Curve type row, specify the method used for distillation: TBP, D86, D2887 or D1160.
- Specify the Basis: By mass or By volume.
- You can adjust the number of distillation Points by adding or removing Point.

After All Data Has Been Added Using Any Method From The Previous Three Methods (i.e. Multi-cut, Single Stream, or Back Blending), The Assay Need To be Characterized By Clicking on "Characterize Assay" Button …

2. Characterizing Assay:-



Assay manager will take a few second to characterize the assay, when the characterization finishes, a **Conventional Results** node will appear under the assay sub-node for each characterized assay. And the status of characterized assays becomes **Characterized Successfully** on the **Petroleum Assays** form.



The **Conventional Results** form consists of the following tabs:

- **Results Summary** tab
- **Pure Component** tab
- **Distillation** tab
- **Property Table** tab
- **Message** tab

By default, the **Message** tab displays all the irregularities found during the assay characterization, such as the violation of the minimum and maximum bounds of a property. Assay Management divides the irregularities into **Error** and **Warning**.

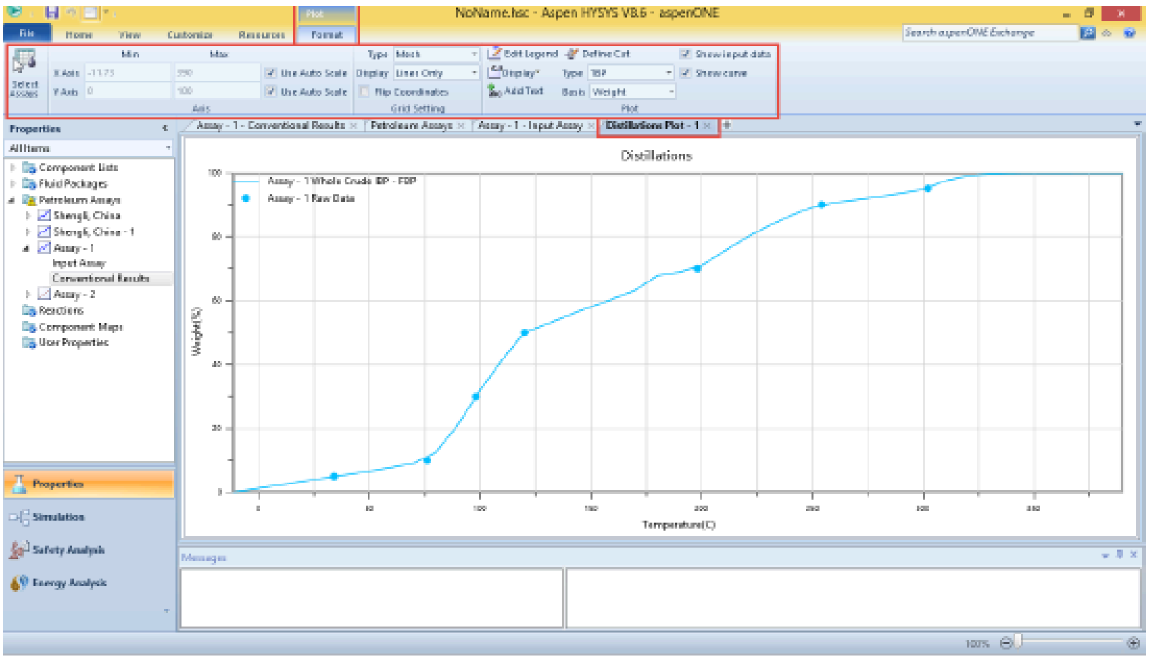
Use the **Results Summary** tab, **Pure Component** tab and **Distillation** tab on the **Conventional Results** form in the same as for the three tabs of the **Input Assay** form (page 6-7).

Data changes on the **Input Assay** form after characterization, such as adding, removing or modifying cut or/and property data, appear automatically on the **Conventional Results** form when the assay is re-characterized. In addition, any new cuts or properties that have been added or modified on the **Conventional Results** forms are retained.

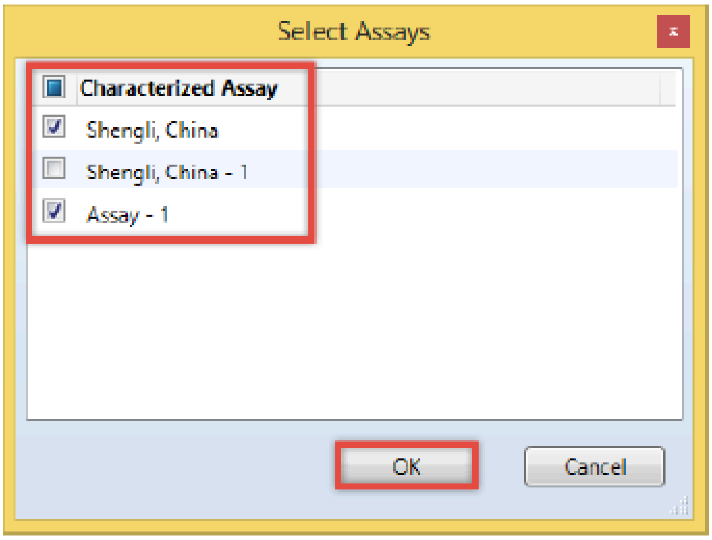
Also after characterization, the **Plot Gallery** appears in the ribbon. These plots can be used to visualize the quality of assay data, and to compare different assays and properties.

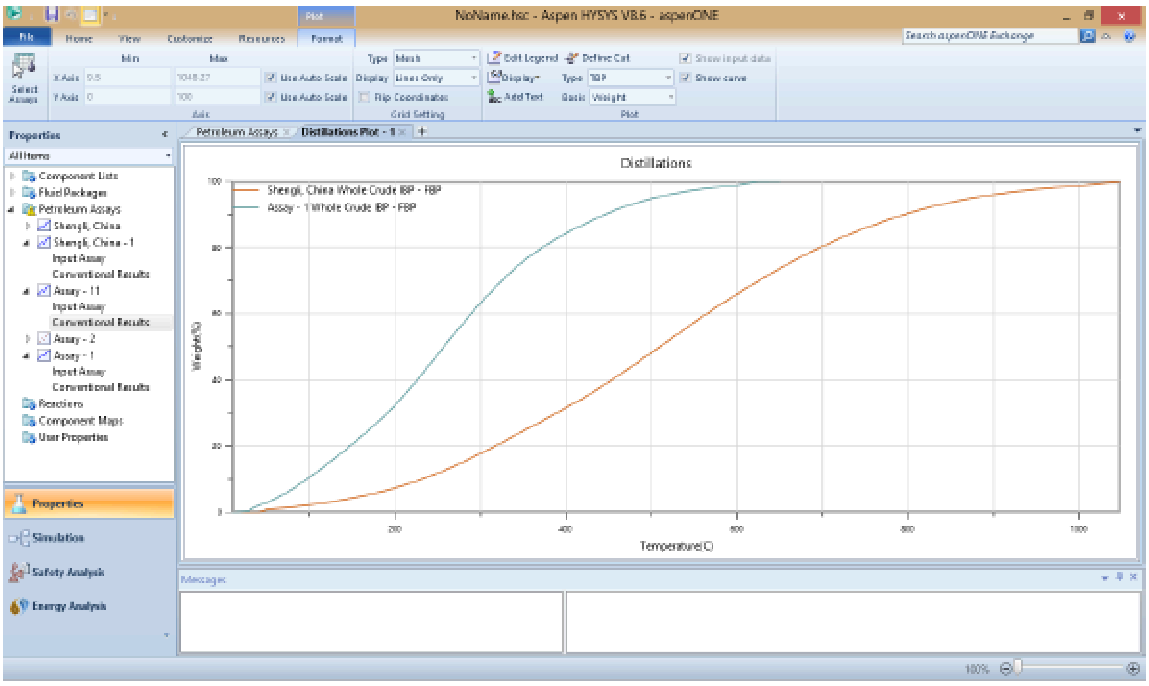
The Plot Gallery of the Assay Management ribbon contains the following plot types:

- ✓ Distillations plot
- ✓ Properties plot
- ✓ Cut Viscosities plot
- ✓ Cut Yields plot
- ✓ PNA plot
- ✓ Viscosities plot



To compare data from more than one crude assay, the second crude must be added, you can add it to the plot by clicking "Select Assays" under the Format tab when the Plot is selected.



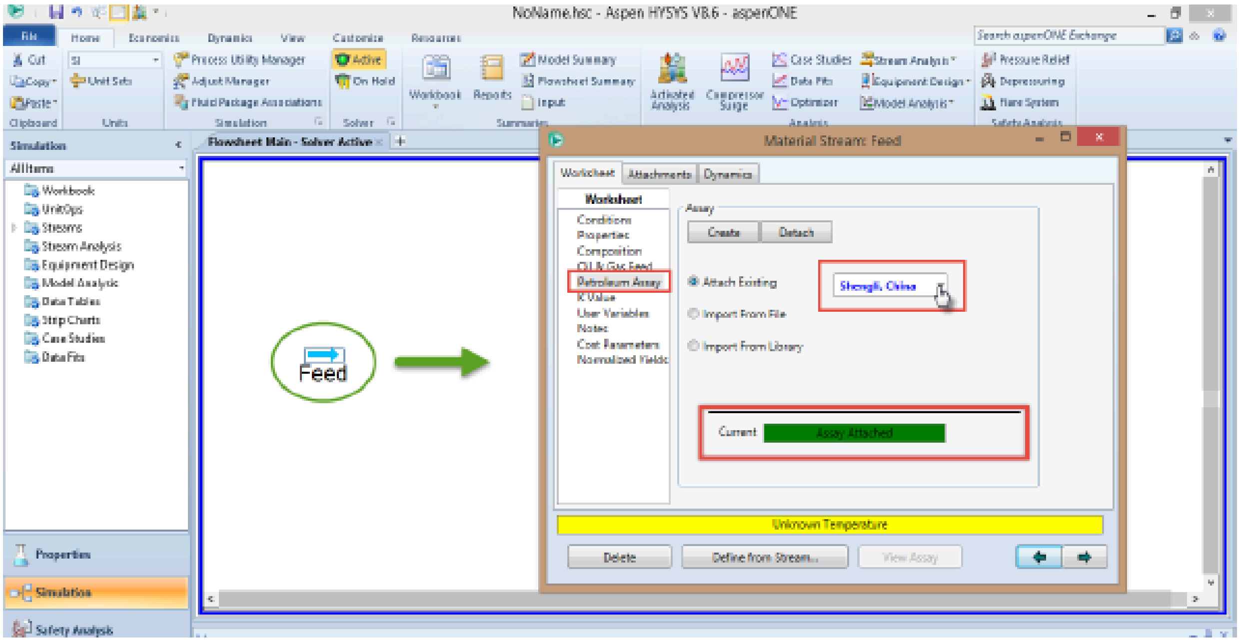


3. Using Assays In The Simulation:-

When an assay has been created and characterized in the Properties Environment, it can be immediately used for modeling in the Simulation Environment. To bring the assay into the simulation, it must be either attached to a stream or added to a Petroleum Feeder unit operation.

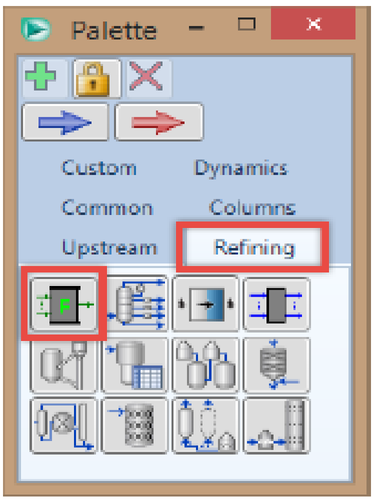
3.1. Attaching Assay to a Stream:

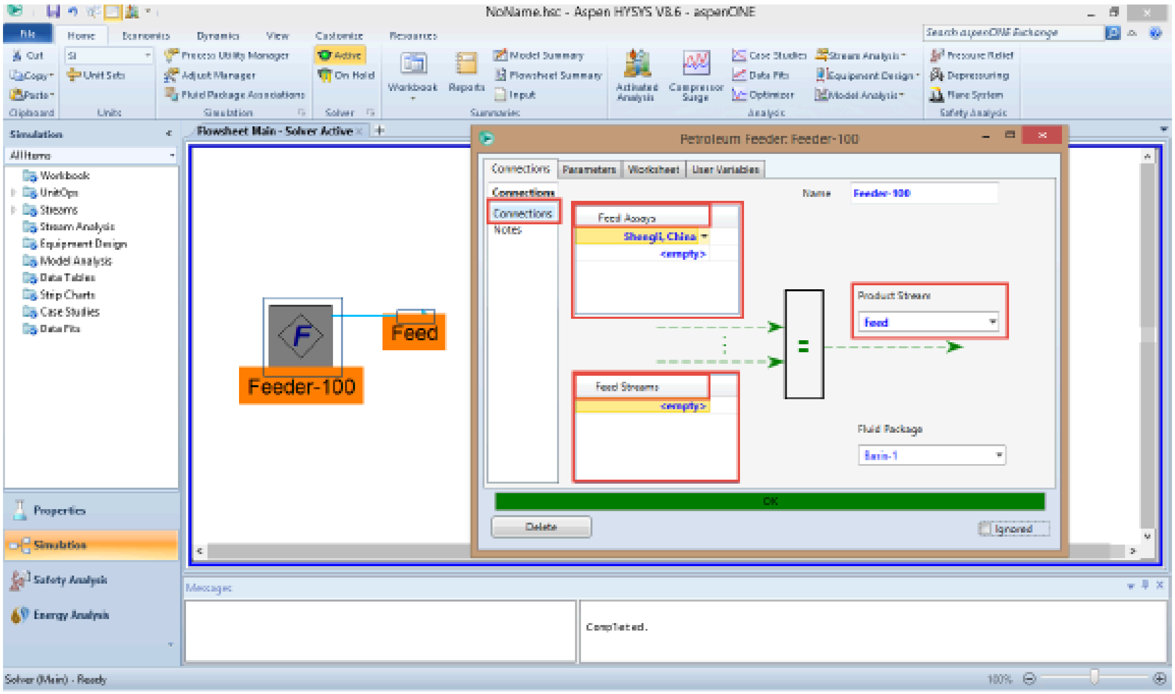
If the assay will be modeled as a single-stream, you can typically attach it to a material stream in the flowsheet. First, add a material stream to the flowsheet. Then, open up the stream view by double-clicking the newly created stream and click on the "Petroleum Assay" option in the Worksheet tab. In the Assay form, select the Attach Existing option which will show a dropdown list where the previously created assay can be selected. Once a characterized assay is attached, it will define the composition and the properties of the stream so that the user just has to enter the conditions of the stream for it to be fully defined.

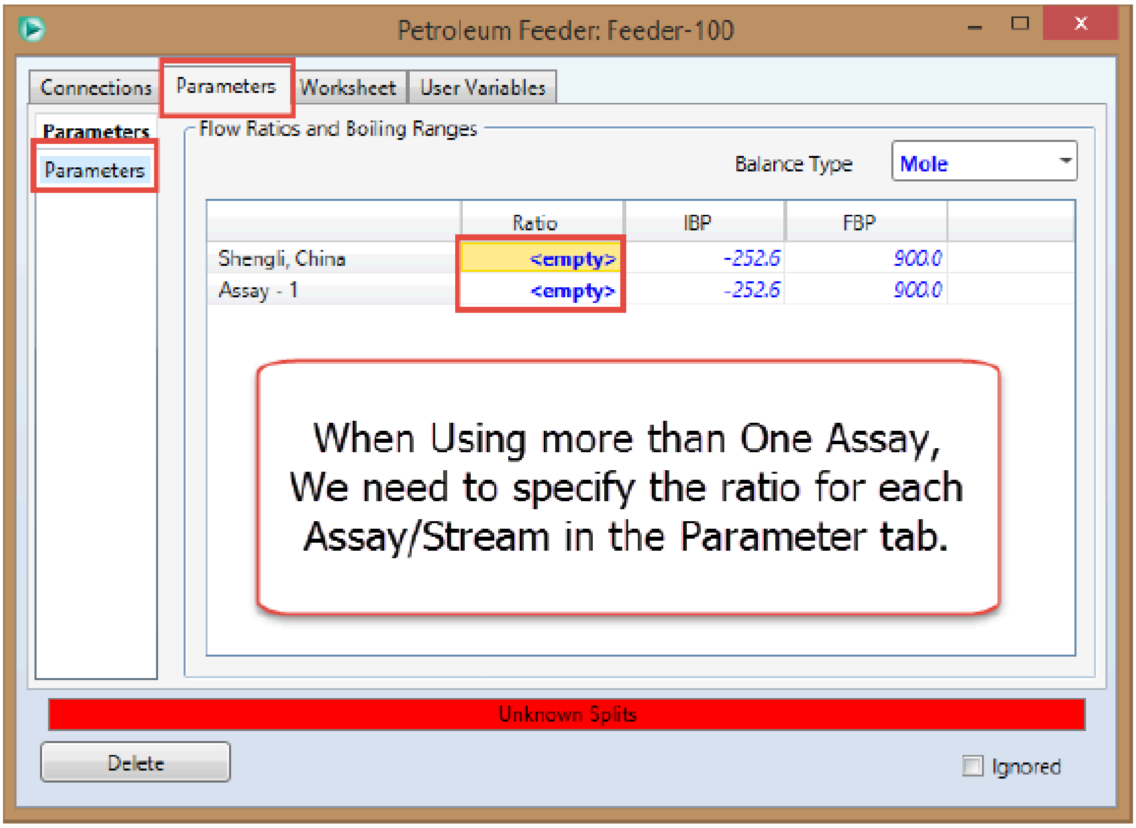


3.2. Adding Assay to Petroelum Feeder:

If more than one assay will be used or if the assay will be mixed with another stream, they can be added to a Petroleum Feeder. In the Feeder, you can select input feed streams and feed assays (as well as mixing specifications including a fluid package) and Aspen HYSYS will calculate a product stream that can be used in the flowsheet.




NoName.hsc - Aspen HYSYS V8.6 - aspenONE
Petroleum Feeder: Feeder-100
Connections
Parameters
Worksheet
User Variables
Name
Feeder-100
Feed Assays
Shengli, China
<empty>
Product Stream
feed
Feed Streams
Fluid Package
Basis-1
OK
Delete
Ignored
Feed
Feeder-100
Completed.


Petroleum Feeder: Feeder-100
Connections
Parameters
Worksheet
User Variables
Flow Ratios and Boiling Ranges
Balance Type
Mole
Ratio
IBP
FBP
Shengli, China
<empty>
-252.6
900.0
Assay - 1
<empty>
-252.6
900.0
When Using more than One Assay, We need to specify the ratio for each Assay/Stream in the Parameter tab.
Unknown Splits
Delete
Ignored

HYSYS OPTIMIZER

➢ Introduction: -

Optimization, in general, can be defined as the process, or methodology of making something (as a design, system, or decision) as fully perfect, functional, or effective as possible; specifically: the mathematical procedures (as finding the maximum of a function) involved in this.

That's mean, we try - in optimization - to find the operating conditions which minimize (or maximize) an Objective Function. This objective function expresses (Mathematically) the intended purpose behind the process of Optimization.

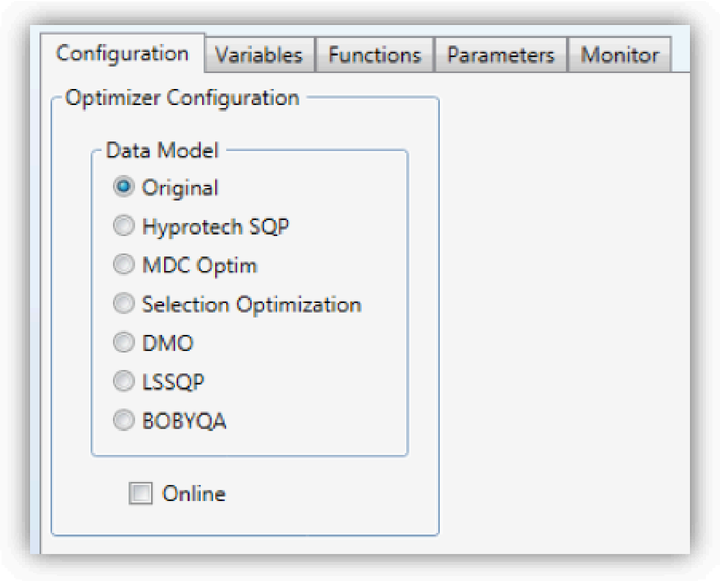
For example, if we want to achieve the highest profit, it means that we want to reach the perfect (Optimum) value of the operating conditions which achieve the highest profit without affecting the required quality thus, the **Objective function** here is the equation that expresses the profit, any variable whose values are manipulated in order to minimize (or maximize) the objective function are called **Primary Variable,** and the required quality specification is a **Constrain** on the extent of change in the allowable values of the variables.

So, Objective Function is created by studying the whole process with its all variables, conditions, and constrains, and studying their relation with the desired goal of the optimization process.

HYSYS contains a multi-variable steady state Optimizer, the object-oriented design of HYSYS makes the Optimizer extremely powerful, since it has access to a wide range of process variables for your optimization study.

- To access the Optimizers:
  - Select the **Home** ribbon tab | **Analysis** section | **Optimizer** icon.
    or
  - Press **F5**.

Use the Configuration tab of the Optimizer to select the Optimizer mode you want to run.



Notes:

- There're many different models of optimization, each differ in the method and algorithm that is used in solving the optimization, we will go through the default model which is the "Original" model.

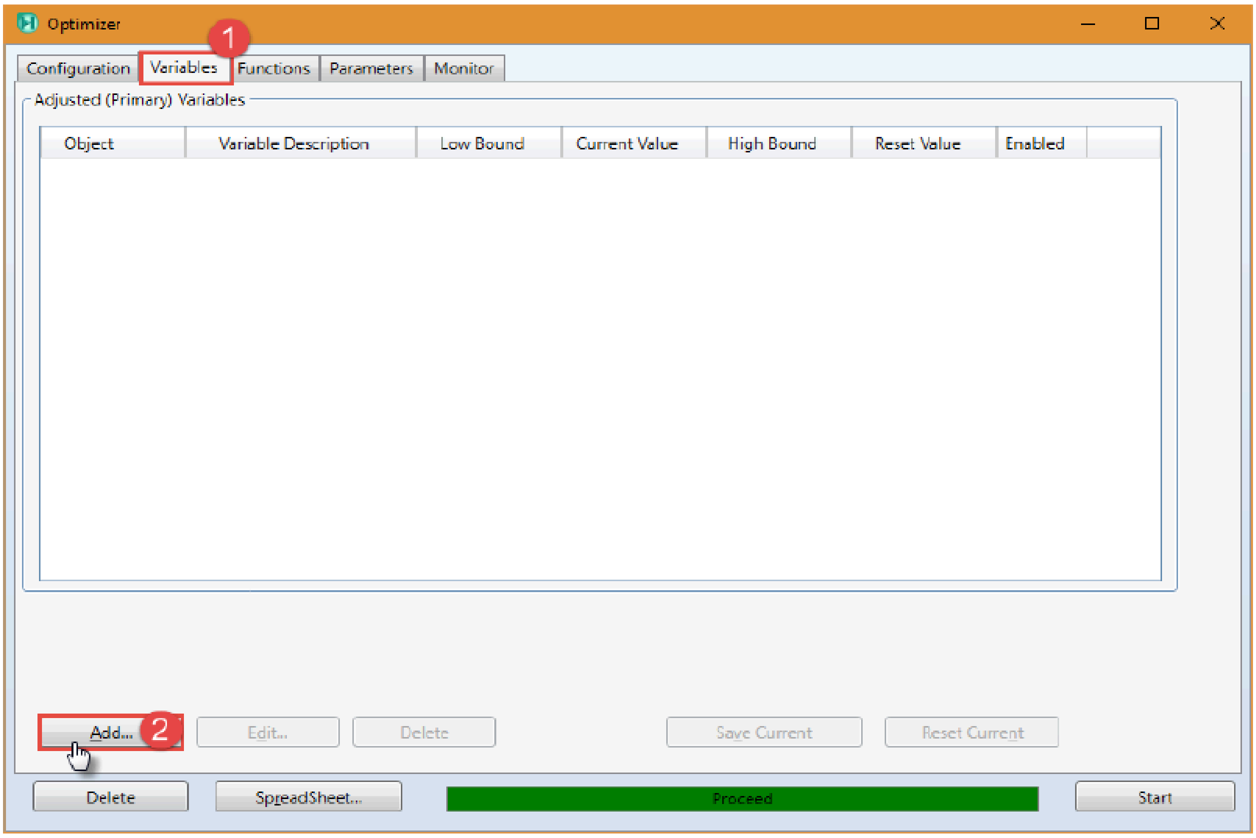
- The Optimizer is available for steady state calculations only. The operation does not run in Dynamic mode.

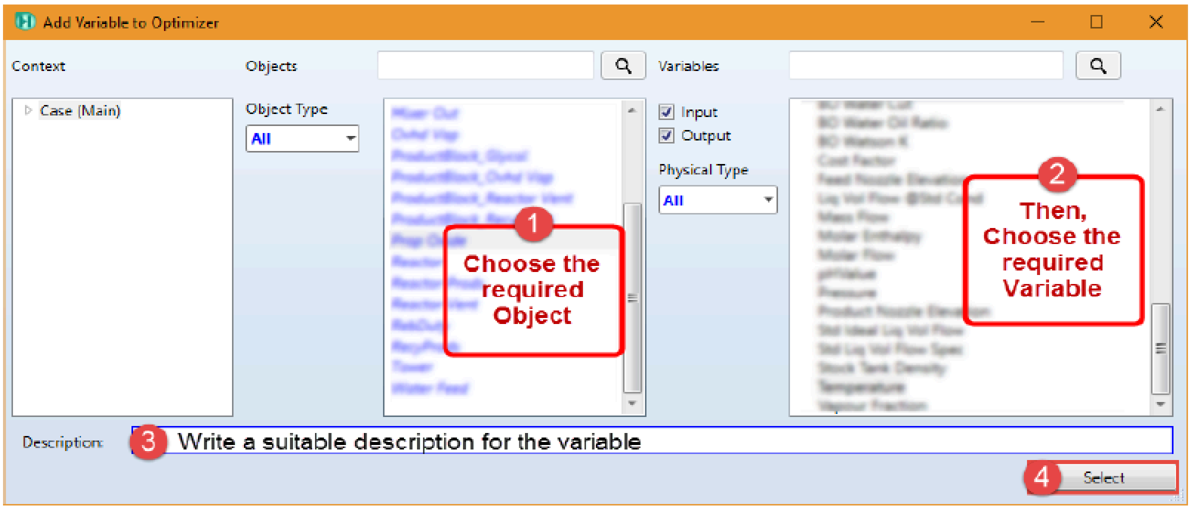
➢ Setting up Original Optimizer: -

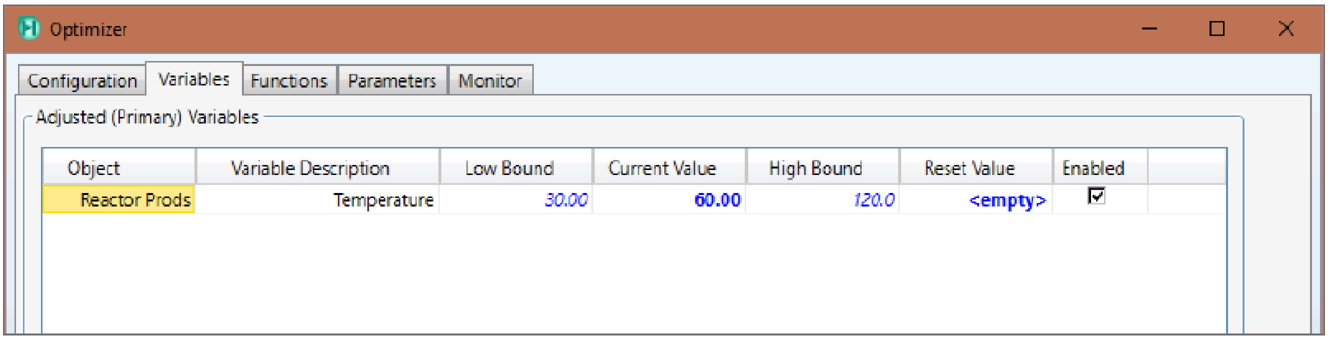
After choosing the optimizer model, we need to setup our optimizer before pressing "start" for starting the solver of the optimization. The setup process goes through different steps in different tabs in the optimizer window, we will discuss each one with details in the following sections.

• The Variables Tab:

On the Variables tab, you can import the primary variables which minimize or maximize the objective function. Any process variable that is modifiable (user-specified) can be used as a primary variable. (**Only user-specified variables** can be used as **Primary Variables**.)


Optimizer
1
Configuration
Variables
Functions
Parameters
Monitor
Adjusted (Primary) Variables
Object
Variable Description
Low Bound
Current Value
High Bound
Reset Value
Enabled
Add...
2
Edit...
Delete
Save Current
Reset Current
Delete
SpreadSheet...
Proceed
Start


Add Variable to Optimizer
Context
Objects
Variables
Case (Main)
Object Type
All
Input
Output
Physical Type
All
1
Choose the required Object
2
Then, Choose the required Variable
Description:
3
Write a suitable description for the variable
4
Select

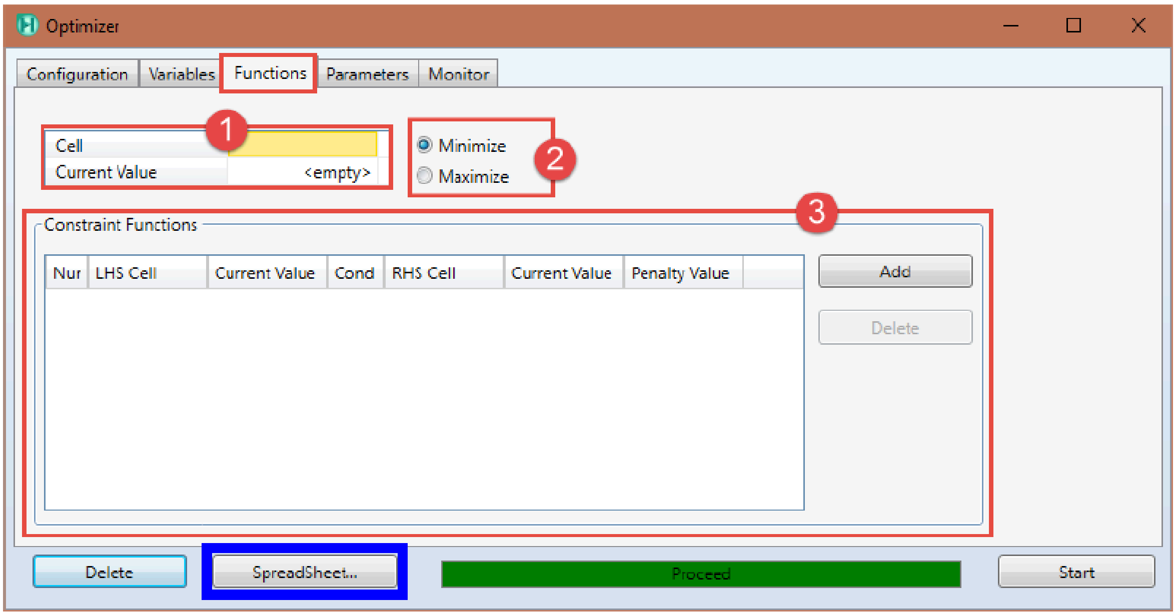


Each primary variable has the following values:

- Low Bound: The Lowest value that optimizer can assign for the variable for solution.
- High Bound: The Highest value that optimizer can assign for the variable for solution.
- Current Value: The Current used value for the variable in the simulation.

In general, the primary variables should not be part of the Objective Function.

- **<u>The Functions Tab:</u>**



In the functions tab we specify the following (according to the above numbering in the picture):

1- Specify the cell in the Spreadsheet that represent the Objective Function.
2- Choose whether we need to maximize or minimize that objective function.
3- Specify the cells in the Spreadsheet that represent the Constrains Function.
   Any constrain function is represented in the form of

   Left hand side ***condition*** ***Right Hand Side***

   a. Click **Add** to add a new constrain. (a new constrain row will be added).
   b. Under **LHS Cell**, select the cell from the spreadsheet that represent the Left side of the constrain function.
   c. Under **Cond**, select the proper condition between the right side and left side (e.g. >, =, <)
   d. Under **RHS Cell**, select the cell from the spreadsheet that represent the Right side of the constrain function.

The Optimizer Spreadsheet

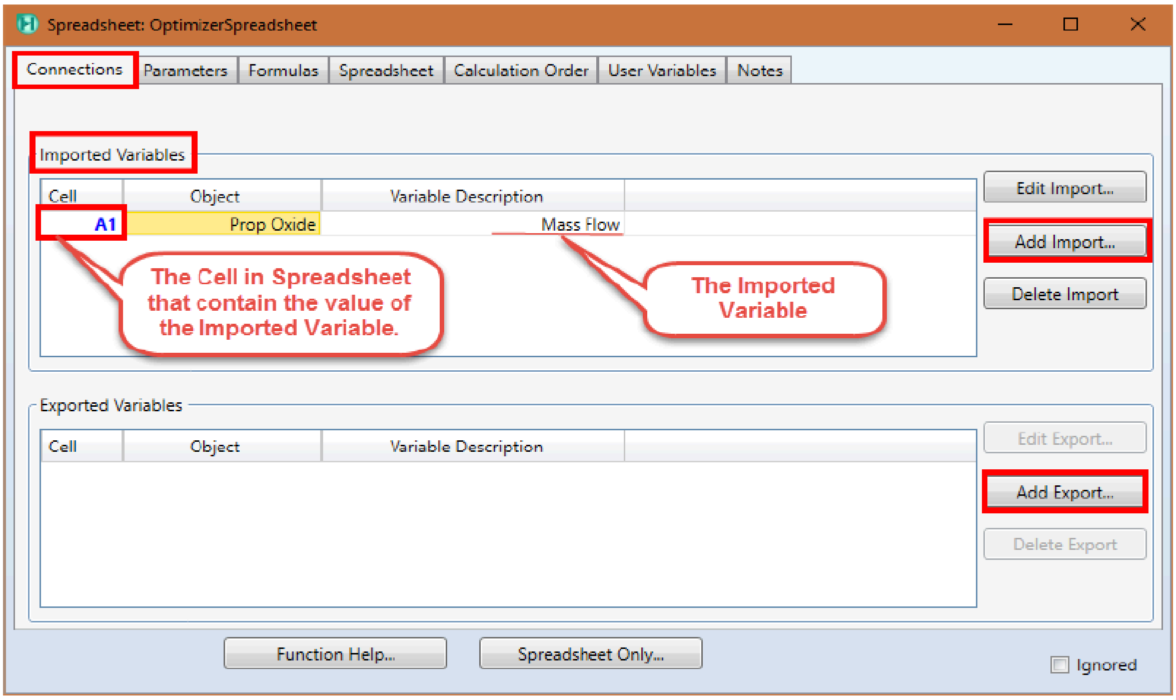
It's clear from the above sequences that in the functions tab we don't create the functions (objective or constrains) in that tab instead, we just select a Cell in the spreadsheet which has the function created in it.

For that reason, we must go through the spreadsheet to know how to build our functions before continue with the remaining Optimizer Tabs.

The Optimizer's Spreadsheet is identical to the HYSYS Spreadsheet operation; process variables can be attached by dragging and dropping, or using the Variable Navigator. Once the necessary process variables are connected to the Spreadsheet, you can construct the Objective Function and any constraints using the standard syntax.

We can access the Optimizer's spreadsheet by clicking the "SpreadSheet" button that locate in the bottom of each tab of the optimizer.

→ **Connections Tab:**



You can import virtually any variable in the simulation into the Spreadsheet, and you can export a cell's value to any specifiable field in your simulation.

There are two methods of importing and exporting variables to and from the Spreadsheet:

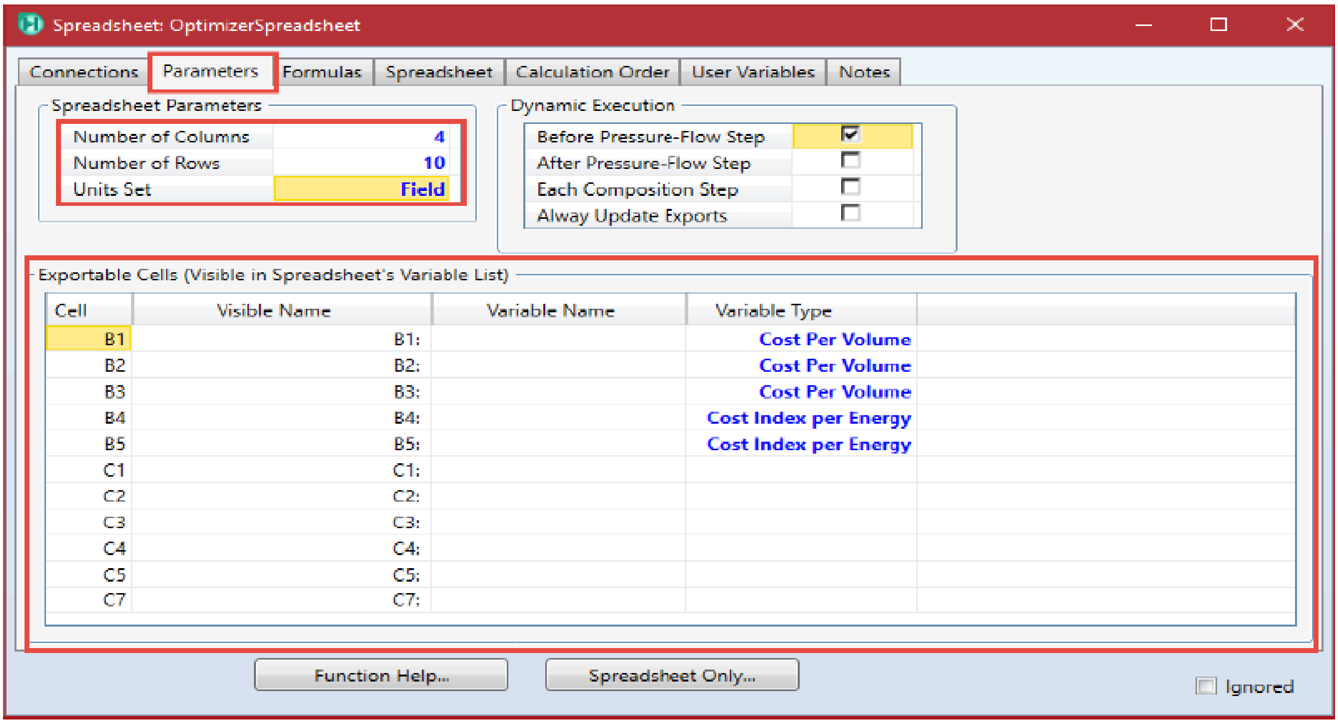
1. Using the Variable Navigator:
   a. On the Connections tab, click the Add Import or Add Export button.
   b. Then using the Variable Navigator, select the variable you want to import or export.
2. Dragging Variables:

   Simply right-click the variable value you want to import, and drag it to the desired location in the Spreadsheet. If you are exporting the variable, drag it from the Spreadsheet to an appropriate location.

After importing variables, In the **Cell** column, type or select from the drop-down list the Spreadsheet cell to be connected to that variable. When you move to the Spreadsheet tab, that variable appears in the cell you specified. (see previous figure).

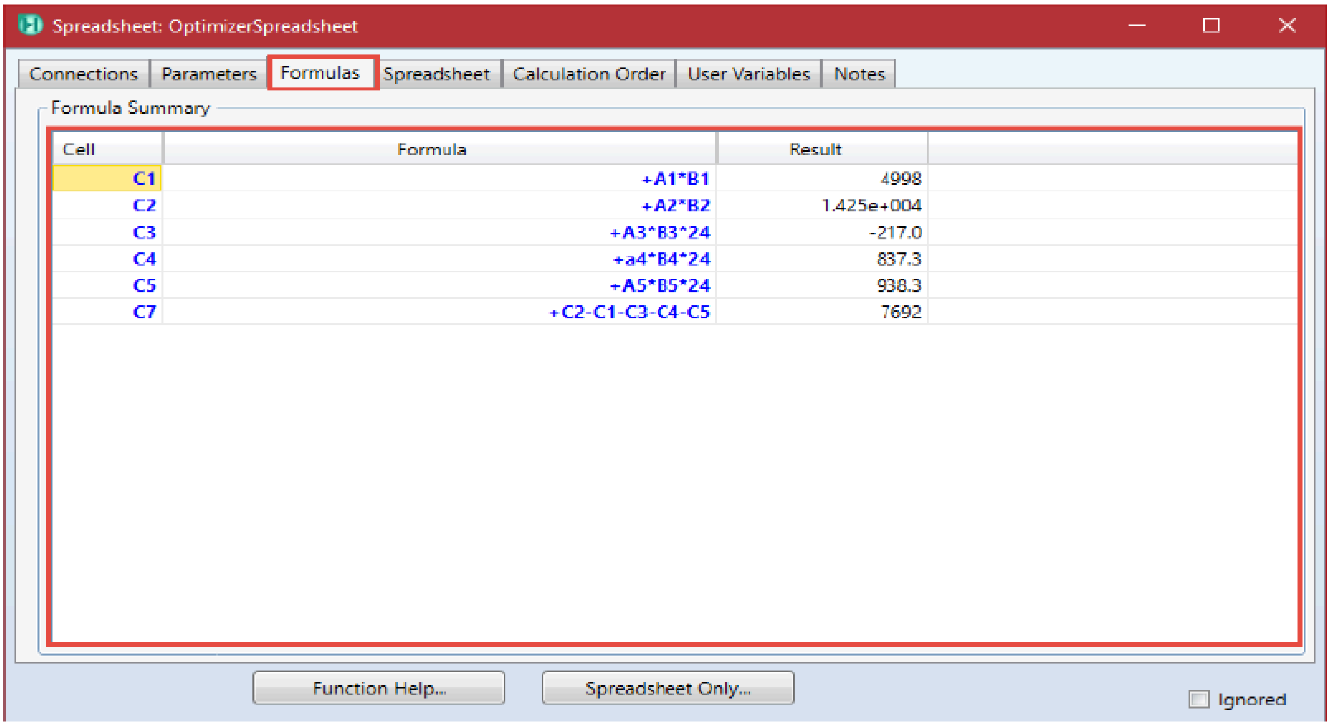
→ **Parameters Tab:**

On the Parameters tab of the Spreadsheet property view, you can set the dimensions of the Spreadsheet and choose a Unit Set.



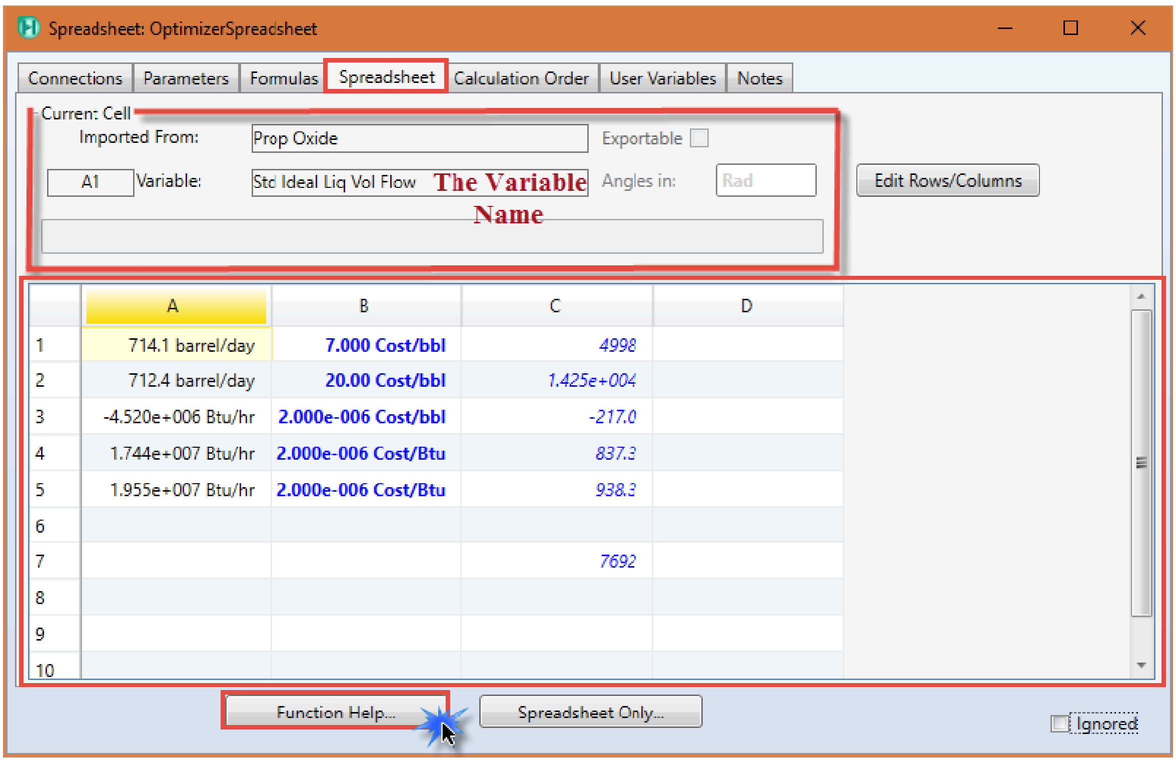
→ Formulas Tab:

The Formulas tab displays a summary of all the formulas included in your spreadsheet. The table lists the name of the cell the formula is located in, the formula and the result of the formula.



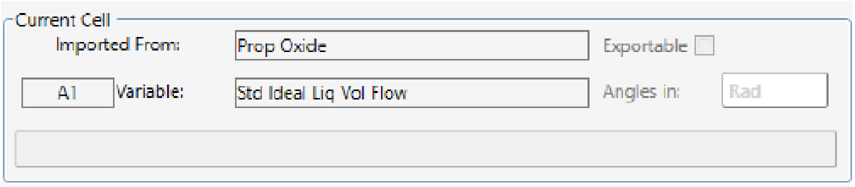
→ SpreadSheet Tab:

The Spreadsheet tab is similar to conventional Spreadsheets (e.g. MS Excel).

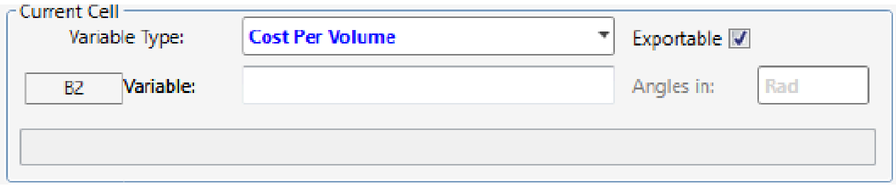


The Current Cell group displays information specific to the contents of the highlighted cell.

- ***If the Cell contain an imported value:*** The object and variable from which the contents of the current cell were imported are shown. You cannot change the Variable name, since it is a HYSYS default.



- ***If the Cell contain a specifiable value:*** The Variable Type and Variable Name are shown. You can choose a new Variable Type from the drop-down list, and you can edit the Variable name.



The HYSYS Spreadsheet has extensive mathematical and logical function capability.

The Available Expressions and Functions property view contains the following tabs:

- Mathematical Expressions
- Logical Expressions
- Mathematical Functions

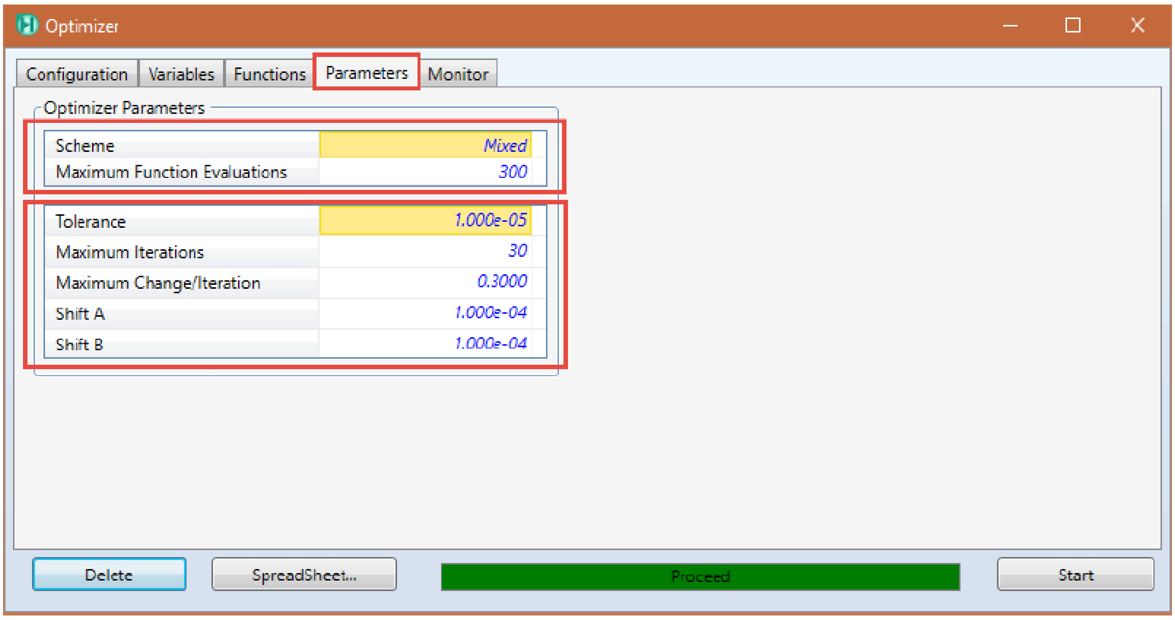
Note: All functions must be preceded by "+" (straight math) or "@" (special functions like logarithmic, trigonometric, logical, and so forth).

To view the available Spreadsheet Functions and Expressions, click the **Function Help** button to open the Available Expressions and Functions property view.

Most Common Used Operations	
Addition	Use the "+" symbol.
Subtraction	Use the "-" symbol.
Multiplication	Use the "*" symbol.
Division	Use the "/" symbol.
Absolute Value	"@Abs".
Power	Use the "^" symbol. Example: +3^3 = 27
Square Root	"@SQRT". Example: @sqrt(16) = 4
Pi	Simply enter "+pi" to represent the number 3.1415...
sin	@sin()
cos	@cos()
tan	@tan()
sinh	@sinh()
cosh	@cosh()
tanh	@tanh()
Ln	@ln()

- **The Parameters Tab:**

The **Parameters** tab is used for selecting the Optimization Scheme and defining associated parameters.



Summary of the Optimizer Schemes				
Method	Unconstrained Problems	Constrained Problems: Inequality	Constrained Problems: Equality	Calculates Derivatives
BOX	X	X		
Mixed	X	X		X
SQP	X	X	X	X
Fletcher-Reeves	X			X
Quasi-Newton	X			X

- <u>**The Monitor Tab:**</u>

The Monitor tab displays the values of the objective function, primary variables, and constraint functions during the Optimizer calculations. New information is updated only when there is an improvement in the value of the Objective Function. The constraint values are positive if inequality constraints are satisfied and negative if inequality constraints are not satisfied.