Conceptual Engineering Product™ 2004

Separation Guide

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1 Separation Manager

1.1 Introduction

The Separation Manager view is used to access, create, or delete the following operations:

- Simple Column
- Complex Column
- Three Product System
- Column Sequencing

These are conceptual design tools that aid in designing mass transfer unit operations such as distillation columns.

1.1.1 Simple Column

The Simple Column operation generates a possible column design for a simple column that could be part of a Direct, Indirect, or Distributed column sequence configuration.

General Procedure

To create a Simple Column:

1. Create a fluid package containing the necessary components and property package.
2. Access the Simple Column operation.
3. Click the **Setup** tab. In this tab, specify the fluid package, components in the feed stream, and the column configuration.
4. Click the **Specifications** tab. In this tab, specify the feed composition, temperature/pressure of the feed, feed flow rate, light key components, and heavy key components.
   DISTIL will begin calculations. If the status bar turns green, a feasible column design has been found.

If a feasible column cannot be found, the status bar will appear red and display a message explaining the error.

5. Review the results of the column design in the **Summary** tab, **Performance** tab, **Plots** tab, Sensitivity Analysis view, Recovery Matrix view, Mass Balance view, and Energy Balance view.
6. If required, click the **Simulate** icon to export the column design to HYSYS for more rigorous calculation.

Simulate icon

1.1.2 Complex Column

The Complex Column operation generates a possible column design from one of the nine complex column configurations available in DISTIL.

General Procedure

To create a Complex Column:

1. Create a fluid package containing the necessary components and property package.
2. Access the Complex Column operation.
3. Click the **Setup** tab. In this tab, specify the fluid package, components in the feed, and column configurations.
4. Click the **Specifications** tab. In this tab, specify the feed composition, temperature/pressure of the feed, feed flow rate, light key components, and heavy key components.
   DISTIL will begin calculations. If the status bar turns green, a feasible column design has been found.

   If a feasible column cannot be found, the status bar will appear red and display a message explaining the error.
5. Review the results of the column design in the **Summary** tab, **Performance** tab, **Plots** tab, Sensitivity Analysis view, Recovery Matrix view, Mass Balance view, and Energy Balance view.
6. If required, click the **Simulate** icon to export the column design to HYSYS for more rigorous calculation.

Simulate icon

1.1.3 Three Product System

The Three Product System (TPS) operation generates possible column designs for several or all of the nine complex column configurations available in DISTIL.

General Procedure

To create a Three Product System:

1. Create a fluid package containing the necessary components and property package.
2. Access the TPS operation.
3. Click the **Setup** tab. On this tab, specify the fluid package, components in the feed, and column configurations.
4. Click the **Specifications** tab. On this tab, specify the feed composition, temperature/pressure of the feed, feed flow rate, light key components, and heavy key components.
   DISTIL will begin calculations. If the status bar turns green, a feasible column design has been found.
5. Review the results of the column design in the **Performance** tab, **Plots** tab, Recovery Matrix view, and Mass Balance view.

If a feasible column cannot be found, the status bar will appear red and display a message explaining the error.

1.1.4 Column Sequencing

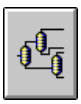
The Column Sequencing operation is used to identify feasible distillation sequences, which separate a specified feed stream into several selected products. The number of stages, the feed tray location and the reflux ratio for each of the feasible distillation column is also determined.

General Procedure

To create a Column Sequence:

1. Create a fluid package containing the necessary components and property package.
2. Access the Column Sequencing operation.
3. Click the **Setup** tab. On this tab, specify the fluid package, and components in the feed.
4. Click the **Specifications** tab. On this tab, specify the feed composition, temperature/pressure of the feed, feed flow rate, light key components, and heavy key components.
5. When you have entered all the values, click the **Generate Feasible Column Sequences** icon to begin calculations and generate feasible designs.
6. When the calculation is complete, the Viewer group will contain a list of feasible designs generated by DISTIL.
7. Select the design listed in the Viewer group to move to design level. The design level allows you to examine the selected design in more details.

If the parameters you enter are not feasible, the status bar will appear red and display a message explaining the error.



Generate Feasible Column Sequences icon

1.1.5 Utility Selection for Condenser/Reboiler

DISTIL identifies a set of feasible utilities to heat/cool the reboiler/condenser of the column from the available utility set.

For example, a reboiler can use any hot utility that is hotter than the reboiler temperature. If the driving force of heat transfer (i.e., ΔT or the difference between reboiler temperature and utility temperature) is very high, then the heat transfer area will be much less. As the heat transfer area decreases, so does the capital cost of the exchanger. To obtain this high driving force, however, the design requires a more expensive hot utility, so there is a balance required between the capital cost and energy cost.

Generally, the operating cost of a hot utility is proportional to its temperature.

This feature is useful when you want to retrofit available heat exchangers for the modified process without any significant capital investment.

By default, DISTIL selects a utility with a minimum operating cost, however, DISTIL also allows you to select other utilities from the set of feasible utilities. By selecting different utilities, you can evaluate the balance of capital costs vs. operating costs.

To select a different utility:

1. Open the Simple Column or Complex Column view.
2. Click the **Performance** tab.
3. On the **Performance** tab, select the **Op. Conditions** page.
4. Locate the **Utility Used** row. The cells within this row contain a down arrow.
5. Click the arrow to open the drop-down list. From this list, select the required utility.
   The utilities in the drop-down list are the utilities that DISTIL determines feasible for the cooling/heating job.

Down arrow icon

This utility selection feature for the condenser/reboiler is available only for the Simple Column and Complex Column operations.

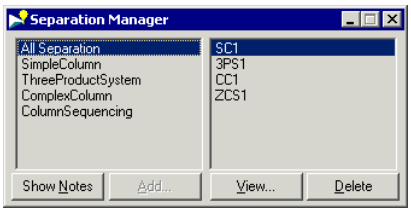
1.2 Separation Manager View

Separation Technology Manager icon

To access the Separation Manager view, do one of the following:

- Click the **Separation Technology Manager** icon in the toolbar.
- From the **Managers** menu, select **Separation Manager**.

Figure 1.1



The Separation Manager view contains four buttons that allow you to manipulate the thermodynamic operations:

Button	Description
Show/Hide Notes	Allows you to access the notes associated with the operations.
Add	Allows you to add operations.
View	Allows you to access existing operations in the case.
Delete	Allows you to delete existing operations in the case.

1.2.1 Adding an Operation

To add an operation:

1. Open the Separation Manager view.
2. In the list on the left, select the type of operation you want to add.
3. Click the **Add** button. The selected type of operation's property view appears.

1.2.2 Editing an Operation

To edit an existing operation:

1. Open the Separation Manager view.
2. In the list on the left, select the type of operation you want to edit. To see all existing operations available, select **All Separation** from the left list.
3. Select the operation you want to edit from the list on the right.
4. Click the **View** button. The selected operation's property view appears.

1.2.3 Deleting an Operation

To delete an existing operation:

1. Open the Separation Manager view.
2. In the list on the left, select the type of operation you want to edit. To see all existing operations available, select **All Separation** from the left list.
3. Select the operation you want to delete from the list on the right.
4. Click the **Delete** button.
5. DISTIL will prompt you for to confirm that you want to delete the selected operation.
   Click the **Yes** button to delete the selected operation, or click the **No** button to keep the selected operation.

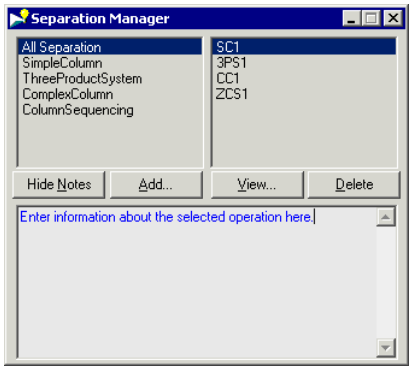
1.2.4 Editing Operation Notes

To edit the notes associated with the operation:

1. Open the Separation Manager view.
2. In the list on the left, select the type of operation you want. To see all existing operations available, select **All Separation** from the left list.
3. Select the operation you want from the list on the right.

4. Click the **Show Notes** button. The notes text editor appears at the bottom of the Separation Manager view.

Figure 1.2



5. Edit the notes associated with the selected operation.
   If there have been no previous notes entered for the selected operation, the notes text editor will appear blank.

The notes text editor in this view is connected to the Notes tab of the selected operation. Any changes made to the information in this text editor of an operation will also appear in the Notes tab of the operation.

6. Once you have completed editing the notes, you can hide the notes text editor by clicking the **Hide Notes** button.

2 Complex Column

2.1 Introduction

Tighter environmental regulations, higher energy costs, and growing competition have increased the need to make distillation systems more efficient. Complex columns offer tremendous opportunity for improving the efficiency of the distillation train.

The Complex Column operation generates a possible column design/ results for one of the nine complex column configurations available in DISTIL.

For more information about the complex column, refer to Section 5.3 - Complex Column Configuration in the Reference Guide.

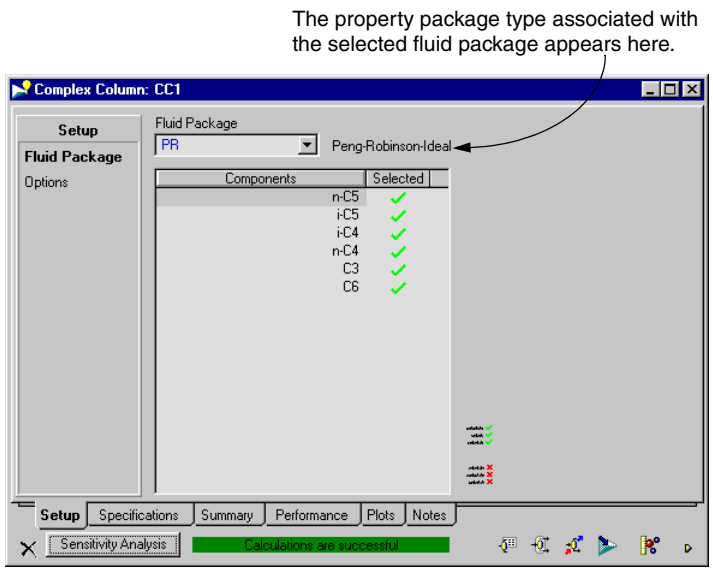
2.2 Complex Column View

To access previously created Complex Column operations, refer to **Section 1.2.2 - Editing an Operation**.

To create a Complex Column operation:

- From the **Features** menu, select **Complex Column Design**.
- From the **Managers** menu, select **Separation Manager**. The manager view appears. In the left list, select **ComplexColumn**, then click the **Add** button.

Figure 2.1



The Complex Column view contains six tabs: Setup, Specification, Summary, Performances, Plots, and Notes. The view also contains nine objects located at the bottom of the view. The following table lists and describes the objects available in the Complex Column view:

Object	Icon	Description
Delete icon		Allows you to delete the current Complex Column operation.
Sensitivity Analysis button		Allows you to access the Sensitivity Analysis view. Refer to the **Sensitivity Analysis View** section for more information.
Status bar		Displays the status of the current Complex Column operation.

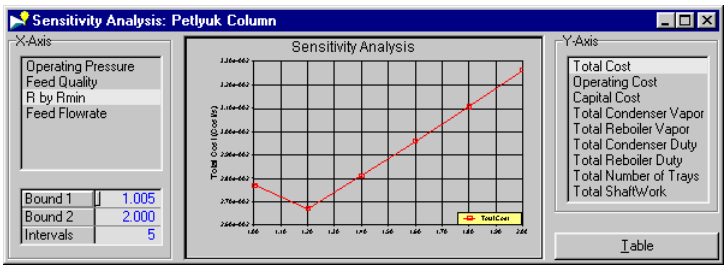
The status bar at the bottom of the view indicates what information is required before the operation can generate results.

Object	Icon	Description
Recovery Matrix icon		Allows you access to the Recovery Matrix view. Refer to the **Recovery Matrix View** section for more information.
Mass Balance icon		Allows you access to the Mass Balance view. Refer to the **Mass Balance View** section for more information.
Energy Balance icon		Allows you access to the Energy Balance view. Refer to the **Energy Balance View** section for more information.
Simulate icon		Allows you to export the complex column to HYSYS for a rigorous simulation. Refer to **Section 4.3 - Simulating in HYSYS** in the **Azeotropic Separation Manager** manual for more information.
() Fraction Basis icon		Allows you to access the Basis Selection view. Refer to the **Basis Selection View** section for more information. Depending on the current composition basis, one of three fraction basis icons will appear at the bottom of the operation view.
Opens Current Page in Separate Window icon		Allows you to open the active tab as a separate view.

Sensitivity Analysis View

The Sensitivity Analysis displays values of performance parameters when the input value is varied.

Figure 2.2



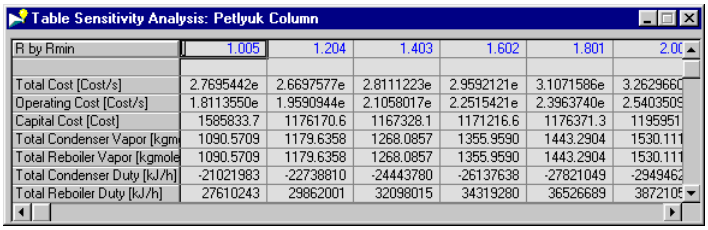
The completed design/ converged complex column acts as a base case for the sensitivity analysis.

To access the Sensitivity Analysis view:

1. Ensure that you have a completed column design.
   For a completed design, the status bar has a green background and displays the message **Calculations are successful**.
2. Click the **Sensitivity Analysis** button. The view appears.

The following table lists and describes the objects available in the Sensitivity Analysis view:

Object	Description
X-Axis list	Allows you to select the variable you want to place on the x-axis of the plot. The x-axis variable is the independent variable you manipulate to observe the changes in the complex column's performance.
Bound 1 cell	Allows you to specify the lowest/minimum value for the x-axis variable.
Bound 2 cell	Allows you to specify the highest/maximum value for the x-axis variable.
Intervals cell	Allows you to specify how many data points/values should be used to calculated the data results.
Sensitivity Analysis plot	Displays the calculated results in a plot format.
Y-Axis list	Allows you to select the performance indicator variable you want to place on the y-axis of the plot. The y-axis variable is the dependent variable that changes based on the x-axis variable value.
Table button	Allows you to access the Table Sensitivity Analysis view. This view displays the calculated dependent variable results in table format.



The first row in the Table Sensitivity Analysis view contains the independent variable. You can change the values of the variable by clicking in the cell and entering the new value.

The completed design/ converged complex column acts as a base case for the sensitivity analysis.

The following table contains the list of independent variables available for the sensitivity analysis feature and the default values:

Variables	Default Bound 1	Default Bound 2
Operating Pressure	0.5 * base case pressure	1.5 * base case pressure
Feed quality	0	1
R/R_{min}	1.05	2
Feed flowrate	0.5 * base case flow rate	1.5 * base case flow rate

The following table lists and describes the output/performance indicator (dependent) variables available for the sensitivity analysis feature:

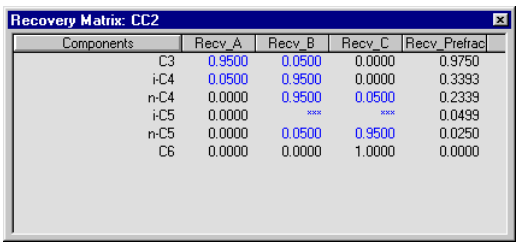
Variable	Description
Total Cost	The sum of the total annual cost for all columns and heat exchangers in the design.
Operating Cost	The sum of the operating cost for all heat exchangers in the design.
Capital Cost	The sum of the capital cost for all columns and heat exchangers in the design.
Total Condenser Vapour	The total vapour from all the condensers in the design.
Total Reboiler Vapour	The total vapour from all the reboilers in the design.
Total Condenser Duty	The total duty from all the condensers in the design.
Total Reboiler Duty	The total duty from all the reboilers in the design.
Total Number of Trays	The sum of the total number of trays from all the columns in the design.
Total Shaftwork	The sum of the total shaftwork from all the refrigerant in the design.

Recovery Matrix View

For more information about the functionality of the Recovery Matrix, refer to **Section 5.3.3 - Specification of Three Product System** in the **Reference Guide**.

The Recovery Matrix view displays the fractional recovery of components in each product stream.

Figure 2.3



Recovery Matrix icon

To access the Recovery Matrix view, click the Recovery Matrix icon. The table will be blank unless you have a completed column design. For a completed design, the status bar has a green background and displays the message **Calculations are successful**.

The fraction values you can modify appear in blue text.

Within the Recovery Matrix view, you can change the composition fraction of the intermediate components within each product stream.

The *** text indicates that the value is the optimized value. To change these optimized values, uncheck the Optimize Interm. Key checkboxes (Specifications tab, Splits page).

Mass Balance View

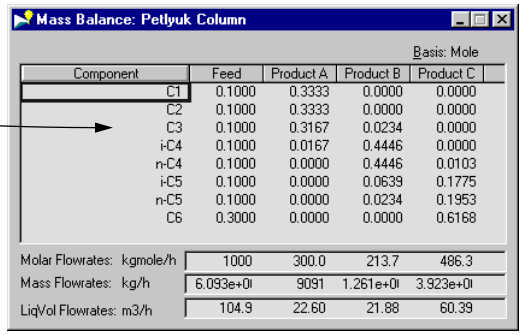
The black text indicates that you cannot change any of the values displayed in this view.

To change the displayed basis of the composition in the table, refer to the **Basis Selection View** section.

The Mass Balance view displays the composition and flow rates of all products and feed streams in a table format.

Figure 2.4

The components are arranged in the order of decreasing volatility.



Overall Mass Balance icon

To access the Mass Balance view, click the Overall Mass Balance icon. The table in the view will be blank until you have a completed column design. For a completed design, the status bar has a green background and displays the message **Calculations are successful**.

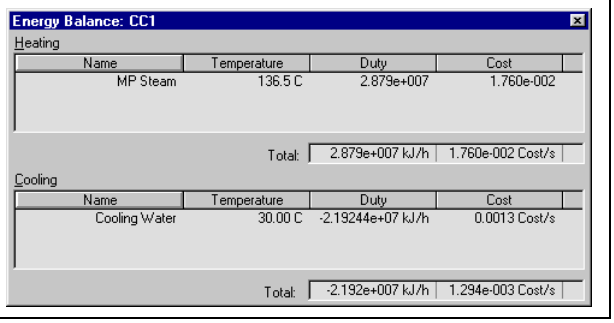
Energy Balance View

The black text indicates that you cannot change any of the values displayed in this view.

You can change the utility type in the Performance tab, Op. Conditions page of the operation view.

The Energy Balance view displays the utility type, temperature, duty, and cost of the condensers and reboilers in the operation.

Figure 2.5



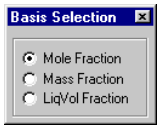
Energy Balance icon

To access the Energy Balance view, click the Energy Balance icon. The table will be blank unless you have a completed column design. For a completed design, the status bar has a green background and displays the message **Calculations are successful**.

Basis Selection View

The Basis Selection view allows you to change the composition basis fraction type displayed in the operation view.

Figure 2.6



Molar Fraction Basis icon

Mass Fraction Basis icon

Volume Faction Basis icon

To change the composition basis using the Basis Selection view:

1. Click on the **Molar/Mass/Volume Fraction Basis** icon to open the Basis Selection view.
2. Use the radio buttons to select the composition basis you want to display in the operation view.
   The fraction basis icon on the operation view changes according to your selection.

3. Click the **Close** icon when you are done.

The following sections describe the tabs in the Complex Column view in detail.

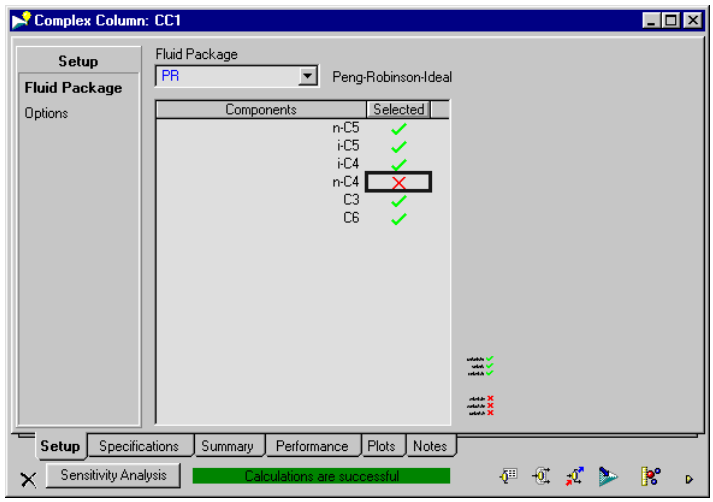
2.2.1 Setup Tab

The Setup tab is divided into two pages: Fluid Package and Options.

Fluid Package Page

The Fluid Package page allows you to select the fluid package and components of the feed stream entering the column.

Figure 2.7



The following table lists and describes the objects available in the Fluid Package page:

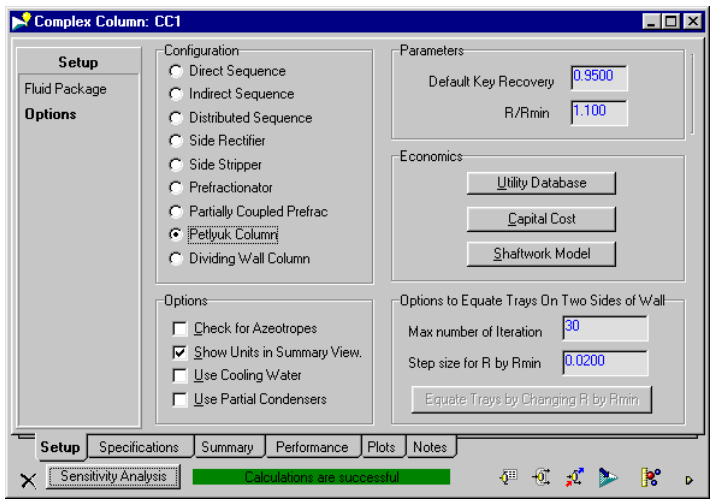
Object	Icon	Description
Fluid Package drop-down list		Allows you to select the fluid package for the feed stream.
Components column		Displays all the components in the selected fluid package.

Object	Icon	Description
Selected column		Allows you to toggle the selection status of the components by clicking the icon in the column. • A green checkmark indicates that the component is selected. • A red cross indicates that the component is not selected.
Unselect All Components icon		Allows you to deselect all the components in the fluid package.
Select All Components icon		Allows you to select all the components in the fluid package.

Options Page

The Options page allows you to specify the type of complex column to be used, the configuration of the column, the sizing and costing methods, the utility database/information that will be used for the operating cost, and more.

Figure 2.8



The following table lists and describes the objects available in the Options page. Some objects may not be available depending on the type of complex column you select.

Object	Description
Configuration group	Contains all the types of complex columns available in DISTIL. To select the type of complex column required, click the appropriate radio button.
Check for Azeotropes checkbox	Allows you to toggle between checking or not checking for azeotropes when designing/calculating the column.
Show Units in Summary View checkbox	Allows you to toggle between displaying or hiding the units on the figure in the Summary tab.
Use Cooling Water checkbox	Allows you to toggle between using or not using cooling water for the condenser.
Use Partial Condenser checkbox	Allows you to toggle between using partial or total condensers for the complex column configuration.
Default Key Recovery field	Displays the recovery fraction of light and heavy key components. The default value is 0.95.
R/Rmin field	Allows you to specify the ratio between the reflux and the minimum reflux. The default value is 1.10.
Utility Database button	Allows you to access the Utility Database view. This view displays the information about all the utilities available in DISTIL.
Capital Cost button	Allows you to access the Capital Cost view. This view contains the options used to calculate the size and cost of the column.
Shaftwork Model button	Allows you to access the ShaftWork Model view. Refer to the **ShaftWork Model View** section for more information.

Refer to **Section 10.2 - Utility Database View** in the **User Guide** for more information.

Refer to **Section 10.1 - Capital Cost View** in the **User Guide** for more information.

Options to Equate Trays on Two Sides of the Wall Group

For more information on the equate trays option, refer to the **Operational Issues with Dividing Wall Column** section from **Section 5.3.5 - Modeling of Complex Columns** of the **Reference Guide**.

The Options to Equate Trays On Two Sides of the Wall group is available only for the Petlyuk and Dividing Wall complex columns. This group contains the options used to equate trays on both sides of the wall.

The following table lists and describes the objects available in this group:

Object	Description
Step Size for R by Rmin field	Allows you to adjust the step size of the operating reflux values. The default value is 0.02.
Max number of Iteration field	Allows you to specify the maximum number of iterations used in the calculations.
Equate Tray by Changing R by Rmin button	Allows you to calculate/design the column limited to equal trays on either side of the wall within the column.

The suggested solution generated by DISTIL depends on the initial case.

There are a number of feasible solutions that will equate the number of trays on both sides of the wall. DISTIL identifies one such feasible solution. It is important to evaluate the solution within the overall context.

If DISTIL is unable to find a feasible solution then try one of the following:

- decrease the step size
- increase the number of iterations

Refer to **Section 2.2.3 - Summary Tab** for more information about the sections in a complex column.

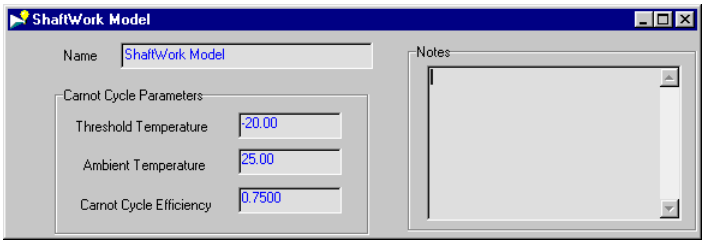
If DISTIL still is unable to solve the complex column, then manually change the R/Rmin value of the rectifying section. To do this, change the R/Rmin value of the column's controlling section (section 3 or section 6) or pre-fractionating section (section 1) on the Summary tab.

ShaftWork Model View

The Shaftwork Model is required when the product stream (from the condenser) needs to be cooled below the ambient temperature.

The Shaftwork Model view allows you to specify the parameters used to calculate the shaft work.

Figure 2.9



Refer to **Section 9.4.5 - Shaft Work Model** from **Reference Guide** for more information.

The following table lists and describes the objects available in the Shaftwork Model view:

Object	Description
Name field	Allows you to change the Shaftwork Model view title by entering a new name in the field.
Threshold Temperature field	Allows you to specify the threshold temperature. The default value is -20°C.

When the product stream is below the ambient temperature, the shaft work value is calculated.

Object	Description
Ambient Temperature field	Allows you to specify the ambient temperature. The default value is 25°C.
Carnot Cycle Efficiency field	Allows you to specify the efficiency of the Carnot cycle. The default value is 0.75.
Notes group	Allows you to enter information regarding the settings of the shaftwork model.

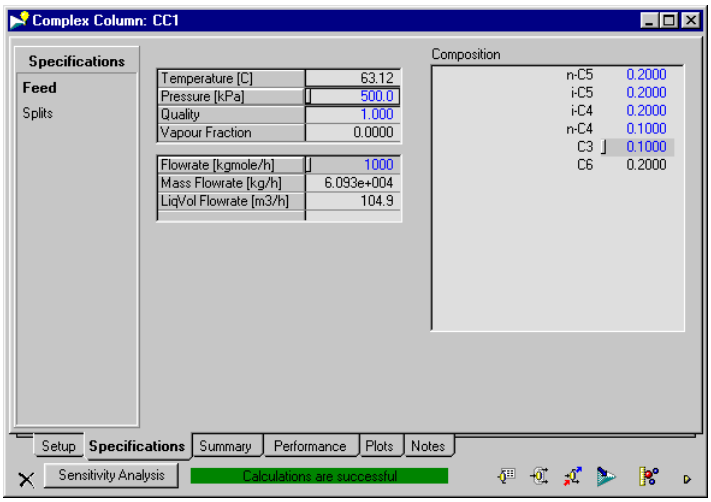
2.2.2 Specifications Tab

The Specifications tab is divided into two pages: Feed and Splits.

Feed Page

The Feed page allows you to manipulate the feed stream.

Figure 2.10



The following table lists and describes the objects available in the Feed page:

You can specify either the temperature or pressure of the feed stream, but not both.

Object	Description
Temperature cell	Allows you to specify the temperature of the feed stream.
Pressure cell	Allows you to specify the pressure of the feed stream

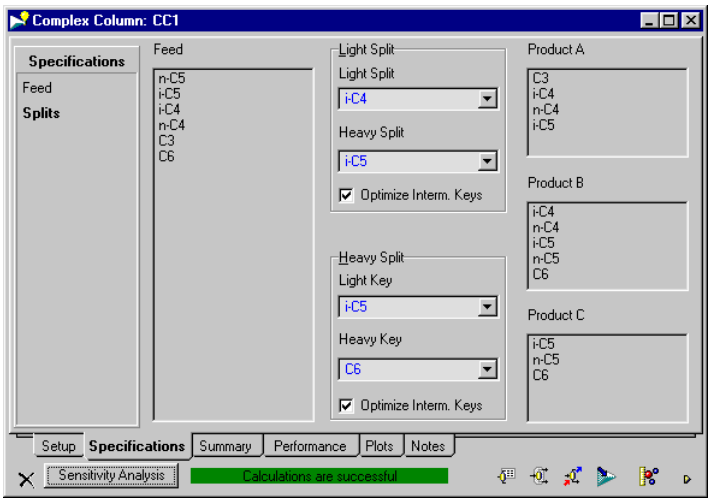
Object	Description
Quality cell	Allows you to specify the quality of the feed stream. The DISTIL default value is 1.
Vapour Fraction cell	Displays the vapour fraction of the feed stream. The feed stream will always be in pure liquid phase, so the vapour fraction value is always 0.
Flowrate cell	Allows you to specify the flowrate of the feed stream. The default value is 1000 kgmole/h.
Mass Flowrate cell	Displays the feed flow rate in terms of mass.
LiqVol Flowrate cell	Displays the feed flow rate in terms of liquid volume.
Composition table	Displays all the components available in the feed stream. You can specify the composition of the feed stream by entering the fraction value in the appropriate cells.

You can specify the flow rate in mole basis only, but DISTIL can display the flow rate in different basis.

Splits Page

The Splits page allows you to specify the key components in the light and heavy splits.

Figure 2.11



The following table lists and describes the objects available in the Splits page:

Object	Description
Feed list	Displays all the components available in the feed stream.
Light Split group	Contains the options used to specify the components that will exit the column in the Product A stream. The Product A stream is also the light split stream. • The Light Split drop-down list allows you to select the “light key” component for the Product A stream. The selected component will be the second last heaviest component allowed in the stream. • The Heavy Split drop-down list allows you to select the “heavy key” component for the Product A stream. The selected component will be the last heaviest component allowed in the stream. The amount of the last component will be small compared to the amount of the component selected in the Light Split drop-down list. • The Optimize Interm. Key checkbox allows you to toggle between optimizing or not optimizing the composition fraction of the other components in the product stream. If you want a certain fraction of intermediate components in a product stream, you have to uncheck this checkbox and specify the fraction you want in the **Recovery Matrix View**.
Heavy Split group	Contains the options used to specify the components that will exit the column in the Product C stream. The Product C stream is also the heavy split stream. • The Light Key drop-down list allows you to select the “light key” component for the Product C stream. The selected component will be the lightest component allowed in the stream. • The Heavy Key drop-down list allows you to select the “heavy key” component for the Product C stream. The selected component will be the heaviest component allowed in the stream. • The Optimize Interm. Key checkbox allows you to toggle between optimizing or not optimizing the composition fraction of the other components in the product stream. If you want a certain fraction of intermediate components in a product stream, you have to uncheck this checkbox and specify the fraction you want in the **Recovery Matrix View**.
Product A list	Displays the components in the Product A stream based on the column design.
Product B list	Displays the components in the Product B stream based on the column design.
Product C list	Displays the components in the Product C stream based on the column design.

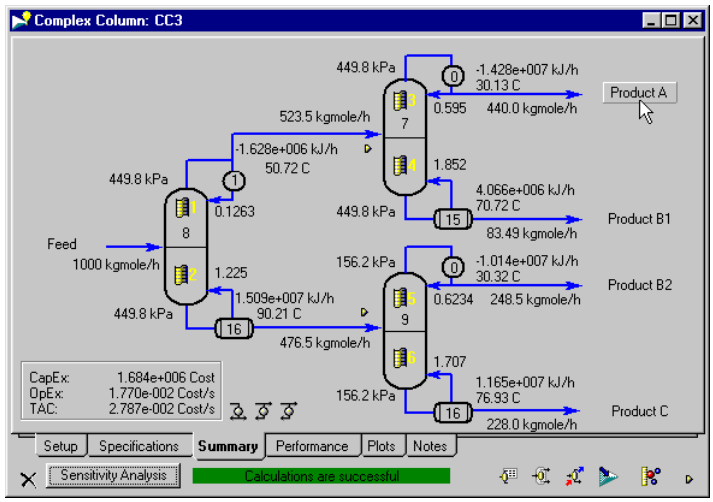
Intermediate components are components that fall between the specified light key and heavy key components.

2.2.3 Summary Tab

The column configuration on the Summary tab varies depending on which complex column configuration you select.

The Summary tab contains a figure that represents the selected complex column configuration and its connectivity. It shows all flowrates, temperatures, pressures, and duties.

Figure 2.12



To access more detailed streams and sections information, move the mouse pointer over the object and click the button that appears. In the above figure the mouse pointer has activated the Product A button for Product A stream.

Some of the objects listed may not be available, depending on the complex column configuration selected.

The following table lists and describes the objects available in the Summary tab:

Object	Icon	Description
Feed Details button		Allows you to access the Feed Stream view. Refer to the **Stream Details View** section for more information.
Section Details icon		Allows you to access the Section number view. Refer to the **Section Details View** section for more information. The number below the icon indicates the tray number in which the section ends.
Stream Detailed Information icon		Allows you to access the Internal Stream view.

Refer to the **Stream Details View** section for more information about the Internal stream view.

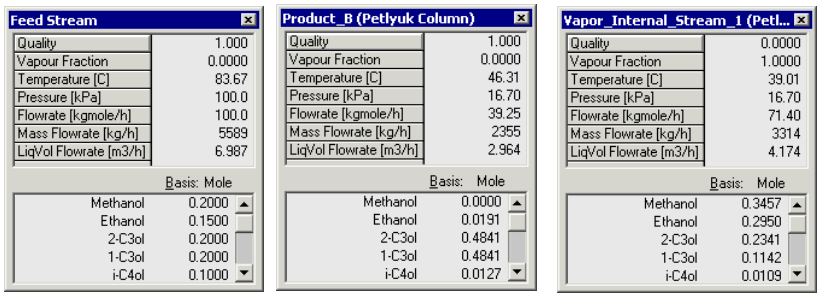
Object	Icon	Description
Condenser icon		Displays the tray number of the stream that enters the condenser.
Reboiler icon		Displays the tray number of the stream that enters the reboiler.
Change () Column Condenser to Partial/Total		Allows you to toggle the condenser of the column number between a partial condenser and a total condenser.
Product A button		Allows you to access the Product A stream view.
Product B() button		Allows you to access the Product B stream(s) view.
Product C button		Allows you to access the Product C stream view.
Summary group		Displays the capital expenditure, operation expenditure, and the total annual cost (TAC) values for the column design.

Refer to the **Stream Details View** section for more information about the Product stream view.

Stream Details View

The Feed Stream and Product Stream views display detailed information about the selected stream. You cannot modify any information in these views.

Figure 2.13



To access the Stream Details view:

1. Ensure that you have a completed column design.
   For a completed design, the status bar has a green background and displays the message **Calculations are successful**.
2. Click the **Summary** tab.
3. Move the mouse pointer over the stream name. The **Feed/Product Details** button will appear.

To access internal streams, click the Stream Detailed Information icon.

4. Click the **Feed/Product Details** button. The Stream Details view for the selected stream will appear.

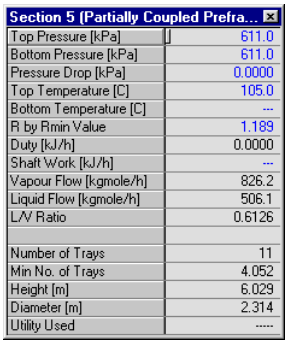
Section Details View

Blue text indicates that the variable can be modified.

The "---" beside a variable indicates that no value has been specified for that variable.

The Section Details view displays detailed information regarding the selected section. You can modify some of the variables in the view.

Figure 2.14



The variables that you can modify are:

- Top Pressure
- Bottom Pressure
- Pressure Drop
- Top Temperature
- Bottom Temperature
- R by Rmin value
- Shaft Work

To access the Section Details view:

1. Ensure that you have a complete column design.
   For a completed design, the status bar has a green background and displays the message **Calculations are successful**.
2. Click the **Summary** tab.
3. Move the mouse pointer over the section in the column that you want to observe. The **Section Details** icon will appear.
4. Click the **Section Details** icon. The Section Details view for the selected section will appear.

Section Details icon for the 6th section in a column

2.2.4 Performance Tab

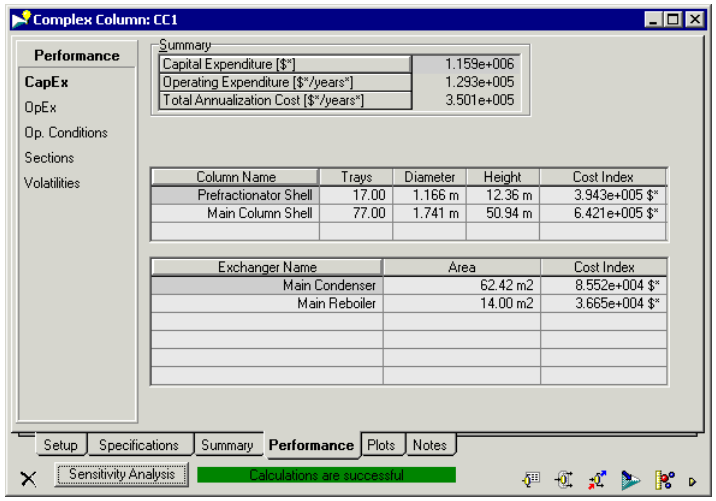
The Performance tab is divided into five pages: CapEx, OpEx, Op. Conditions, Sections, and Volatilities.

CapEx Page

Refer to **Chapter 10 - Sizing and Costing** in the **User Guide** for more information.

The CapEx page displays all the capital cost information for the selected complex column configuration. You cannot edit any of the values from this page.

Figure 2.15

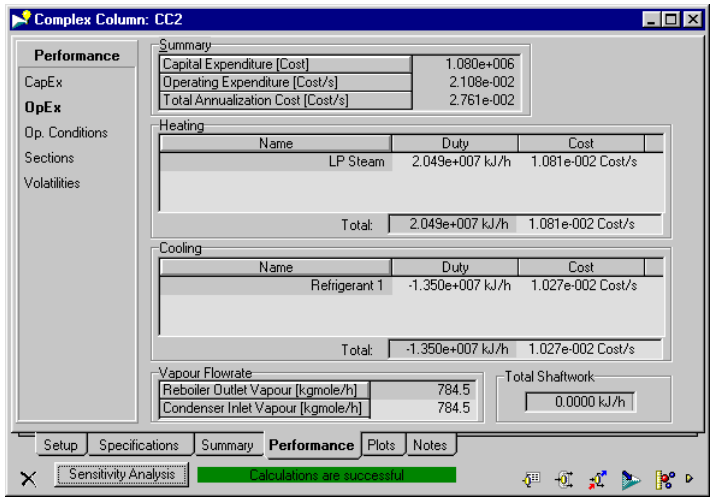


OpEx Page

Refer to **Chapter 10 - Sizing and Costing** in the **User Guide** for more information.

The OpEx page displays all the operating cost information for the selected complex column configuration. You cannot edit the values on this page.

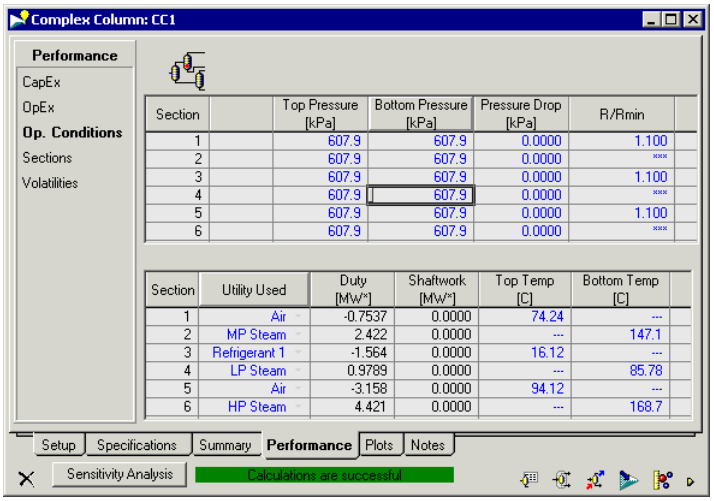
Figure 2.16



Op. Conditions Page

The Op. Conditions page allows you to change the operating conditions in each section of the column(s).

Figure 2.17



The icon at the top of the table indicates with a red dot which section you have selected in the table. For example, in the figure above the selected section is 6 in the table, and the red dot appears in section 6 on the icon.

--- indicates that no value has been specified for that variable.

******* indicates that the variable value has been optimized. You cannot change this value unless you uncheck the Optimize Interm. Key checkbox (Specifications tab, Splits page).

The following table lists and describes the objects available in the Op. Conditions page:

Object	Description
Section column	Displays the section number.
Top Pressure column	Allows you to specify the pressure at the top tray of the active section.
Bottom Pressure column	Allows you to specify the pressure at the bottom tray of the active section.
Pressure Drop column	Allows you to specify the pressure difference between the top and bottom tray of the active section.
R by Rmin Value column	Allows you to specify the ratio of reflux/minimum reflux for the active section.
Utility Used column	Allows you to select a different utility for the active section from the drop-down list.

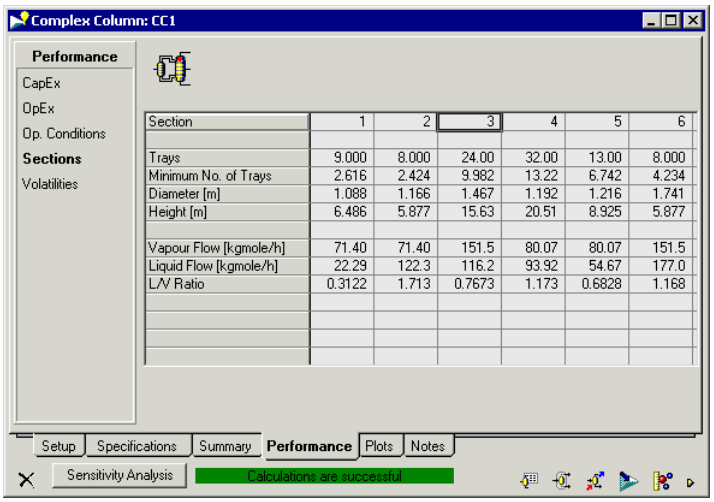
Refer to **Section 1.1.5 - Utility Selection for Condenser/Reboiler** for information on how DISTIL selects a utility.

Object	Description
Duty column	Displays the amount of energy per hour required by the selected utility.
Shaft Work column	Displays the amount of energy per hour required by the shaftwork.
Top Temp column	Allows you to specify the temperature of the stream within the utility.
Bottom Temp column	Allows you to specify the temperature of the stream within the utility.

Sections Page

The Sections page allows you to change the configuration of each section in the complex column design.

Figure 2.18



The icon at the top of the table indicates with a red dot which section you have selected in the table. For example, in the figure above the selected section is 2 in the table, and the red dot appears in section 2 on the icon.

The following table lists and describes the objects available in the Sections page:

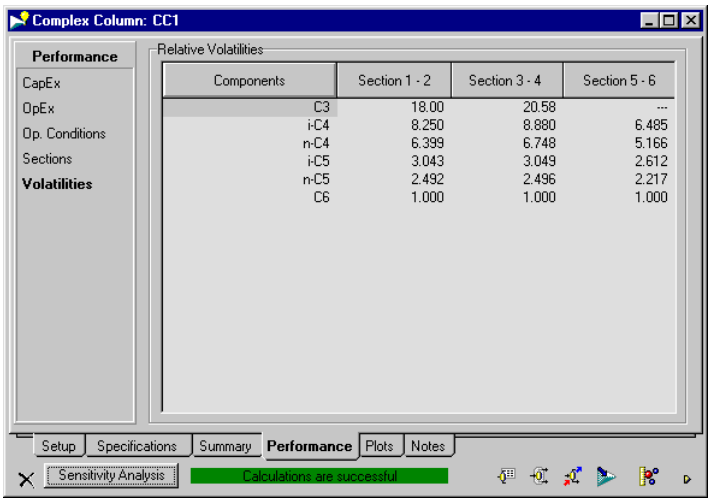
Object	Description
Trays cell	Displays the number of trays in the selected section of the column.
Minimum No. of Trays cell	Displays the minimum number of trays allowed in the selected section of the column.
Diameter cell	Displays the diameter of the trays in the selected section of the column.
Height cell	Displays the height of the selected section of the column.
Vapour Flow cell	Displays the vapour flow rate for the selected section of the column.
Liquid Flow cell	Displays the liquid flow rate for the selected section of the column.
L/V Ratio cell	Displays the liquid/volume ratio value for the selected section of the column.

The values displayed are based on DISTIL calculations for a feasible column configuration.

Volatilities Page

The Volatilities page displays the calculated relative volatility of each component at different sections in the column design.

Figure 2.19



The relative volatility values depend strongly on the pressure, temperature, and the composition of the mixture.

Relative volatility represents the ease of separation of a component in the mixture. It is defined using the least volatile component as the base, which means the relative volatility of the heaviest component in the mixture is 1. The higher the value of volatility, the easier it is to separate the component from the heaviest component using distillation.

For information on short-cut models, refer to **Section 4.4.1 - Shortcut Method** in the **Reference Guide**.

This information is useful for judging the assumptions of short-cut models such as Underwood and Winn's method. If the relative volatility values in different sections are significantly different, then the results of short-cut methods are less accurate.

DISTIL recommends you should examine the relative volatility values to determine if the short-cut method is accurate or not.

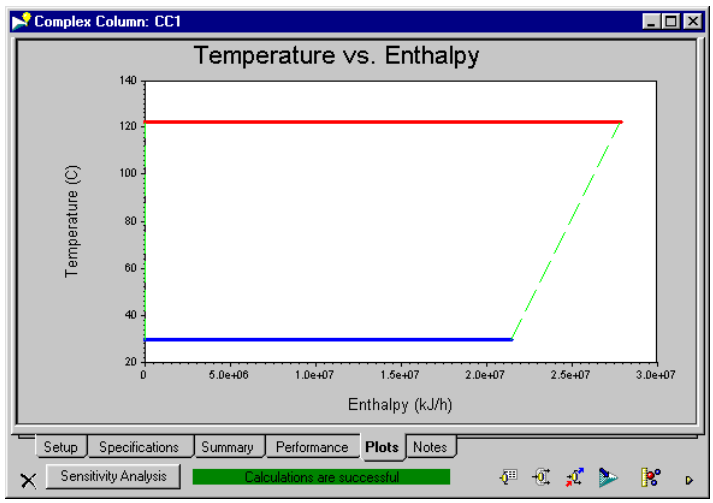
In all cases, the component order should not change with operating conditions such as pressure, temperature, and composition. If the order of decreasing volatility changes, then the short-cut performance models are inappropriate for the selected system.

2.2.5 Plots Tab

For information about manipulating plots, refer to **Section 7.4 - Plot Area** and **Chapter 8 - Plot Properties** in the **User Guide**.

The Plots tab contains a temperature vs. enthalpy graph.

Figure 2.20



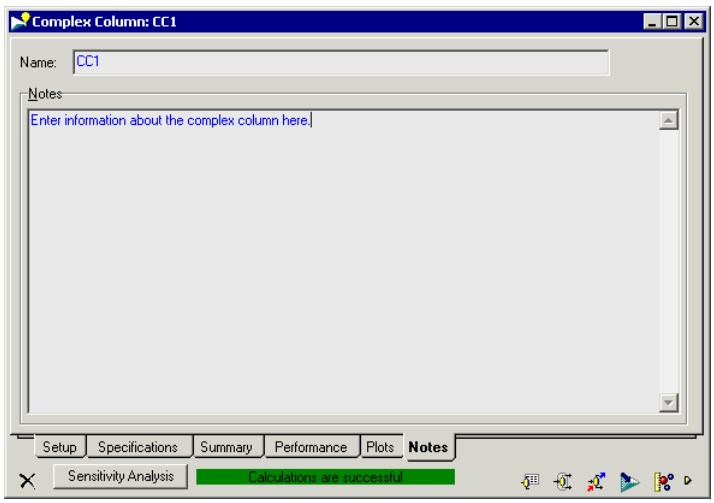
2.2.6 Notes Tab

The Notes tab allows you to:

- Change the name of the operation by entering a new name in the **Name** field. The new name will appear in the title bar of the operation view.
- Enter information regarding the operation in the **Notes** text editor.

Any changes made to the information in the Notes tab will appear in the text editor located at the bottom of the Separation Manager view when the Show Notes button has been clicked.

Figure 2.21



3 Three Product System

3.1 Introduction

For more information about complex column, refer to **Section 5.3 - Complex Column Configuration** in the **Reference Guide**.

Tighter environmental regulations, higher energy costs and growing competition have increased the need to make distillation systems more efficient. Complex columns offer tremendous opportunity in improving efficiency of the distillation train.

The Three Product System (TPS) operation generates possible column designs/results for several or all of the nine complex column configurations available in DISTIL. This feature is useful if you want to compare the results from several configurations.

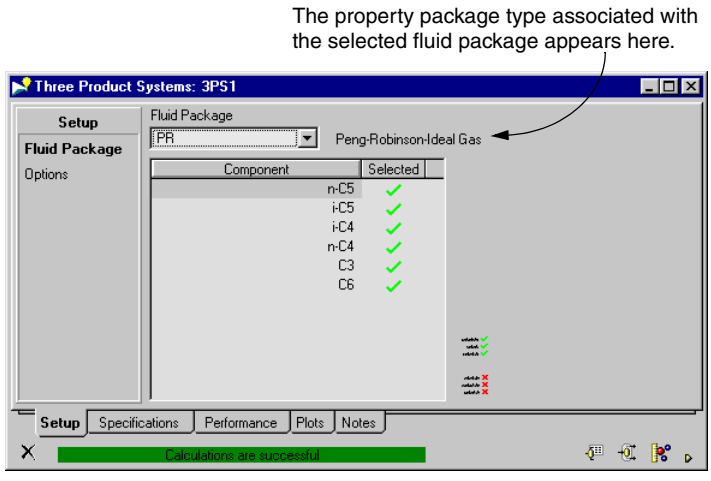
3.2 Three Product System View

To access previously created TPS operation, refer to **Section 1.2.2 - Editing an Operation**.

There are two ways to create a Three Product System (TPS) operation:

- From the **Features** menu, select **Three Product System**.
- From the **Managers** menu, select **Separation Manager**. The manager view appears. From the left list, select **ThreeProductSystem**, then click the **Add** button.

Figure 3.1



The Three Product System view contains five tabs: Setup, Specifications, Performance, Plots and Notes.

The TPS view also contains six objects located at the bottom of the view. The following table lists and describes the objects available in the TPS view:

Object	Icon	Description
Delete icon		Allows you to delete the current TPS operation.
Status bar		Displays the status of the current TPS operation.
Recovery Matrix icon		Allows you access to the Recovery Matrix view. Refer to the **Recovery Matrix View** section for more information.
Overall Mass Balance icon		Allows you access to the Mass Balance view. Refer to the **Mass Balance View** section for more information.
() Fraction Basis icon		Allows you to access the Basis Selection view. Refer to the **Basis Selection View** section for more information. The icon changes depending on which basis view you have selected.
Opens Current Page in Separate Window icon		Allows you to open the active tab as a separate view.

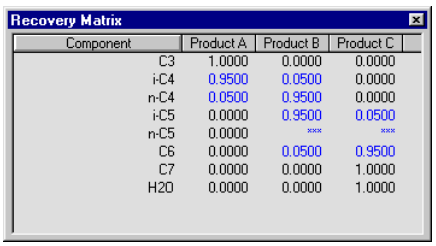
The status bar at the bottom of the view indicates what information is required before the operation can generate results.

Recovery Matrix View

The Recovery Matrix view displays the fractional recovery of components in each product stream.

For more information about the purpose of the Recovery Matrix, refer to **Section 5.3.3 - Specification of Three Product System** in the **Reference Guide**.

Figure 3.2



Recovery Matrix icon

To access the Recovery Matrix view, click the Recovery Matrix icon. The table will be blank unless you have a completed column design. For completed column designs, the status bar has a green background and displays the message **Calculations are successful**.

Blue text indicates where you can change the composition fraction of the intermediate components within each product stream.

The *** text indicates that the value is the optimized value. To change these optimized values, uncheck the Optimize Interm. Key checkboxes (Specifications tab, Splits page).

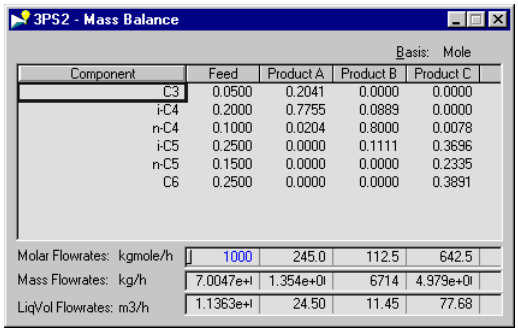
Mass Balance View

The black text indicates that you cannot change any of the values displayed in this view.

You can change the feed flow rate in the Specifications tab, Feed page.

The Mass Balance view displays the mass flow rate of the components in each product stream in a table format.

Figure 3.3



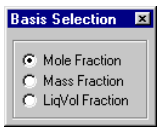
Mass Balance icon

To access the Mass Balance view, click the Mass Balance icon. The table will be blank unless you have a completed column design. For completed column designs, the status bar has a green background and displays the message **Calculations are successful**.

Basis Selection View

The Basis Selection view allows you to change the composition basis fraction type displayed in the operation view.

Figure 3.4



Molar Fraction Basis icon

Mass Fraction Basis icon

Volume Faction Basis icon

To change the composition basis using the Basis Selection view:

1. Click on the **Molar/Mass/Volume Fraction Basis** icon to open the Basis Selection view.
2. Use the radio buttons to select the composition basis you want to display in the operation view.
   The fraction basis icon on the operation view changes according to your selection.
3. Click the **Close** icon ✕ when you are done.

The following sections describe the tabs in the TPS view in detail.

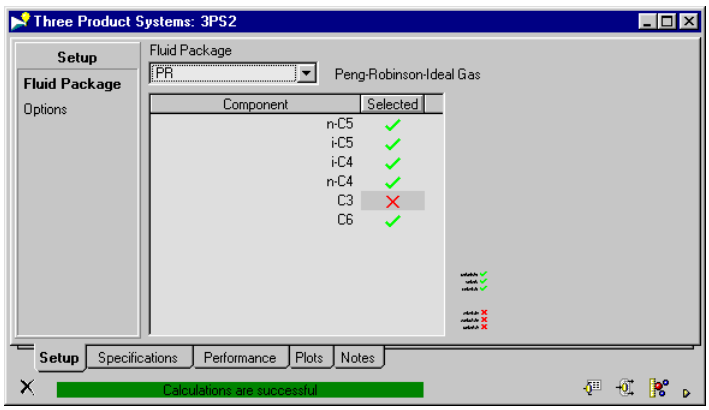
3.2.1 Setup Tab

The Setup tab is divided into two pages: Fluid Package and Options.

Fluid Package Page

The Fluid Package page allows you to select the fluid package and components of the feed stream entering the column.

Figure 3.5



The following table lists and describes the objects available in the Fluid Package page:

Object	Icon	Description
Fluid Package drop-down list		Allows you to select the fluid package for the feed stream.
Component column		Displays all the components in the selected fluid package.
Selected column		Allows you to toggle the selection status of the components by clicking the icon in the column.
Unselect All Components icon		Allows you to deselect all the components in the fluid package.
Select All Components icon		Allows you to select all the components in the fluid package.

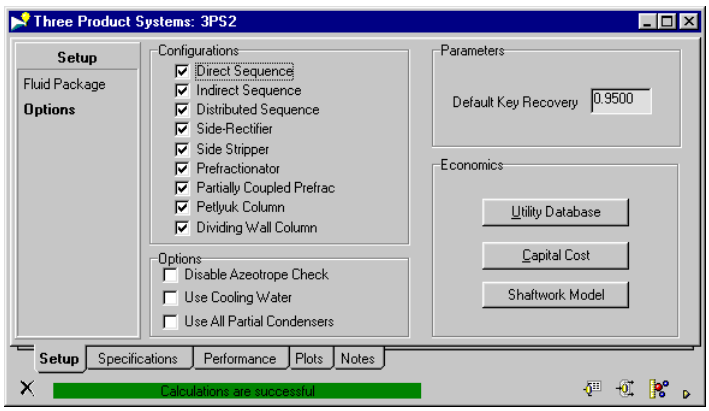
A green checkmark indicates that the component is selected.

A red cross indicates that the component is not selected.

Options Page

The Options page allows you to select the type of complex columns to be generated, the configuration of the columns, the sizing and costing methods, the utility database/information that will be used for the operating cost, and more.

Figure 3.6



The following table lists and describes all the objects that are available in the Options page.

Select or deselect the type of complex columns you want to generate by checking or unchecking the appropriate checkboxes.

Object	Description
Configurations group	Contains all the types of complex column available in DISTIL.
Default Key Recovery field	Displays the recovery fraction of light and heavy key components. The default value is 0.95.
Use Cooling Water checkbox	Allows you to toggle between using or not using cooling water for the condensers.
Use All Partial Condenser checkbox	Allows you to toggle between using partial or total condensers for all the selected columns.
Disable Azeotrope Check checkbox	Allows you to toggle between checking or not checking for azeotropes when designing/calculating the columns.
Utility Database button	Allows you to access the Utility Database view. This view displays the information about all the utilities available in DISTIL.
Capital Cost button	Allows you to access the Capital Cost view. This view contains the options used to calculate the size and cost of the column.
Shaftwork Model button	Allows you to access the ShaftWork Model view. Refer to the **ShaftWork Model View** section for more information.

Refer to **Section 10.2 - Utility Database View** from the **User Guide** for more information.

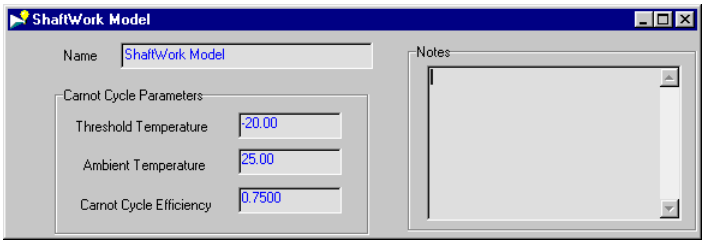
Refer to **Section 10.1 - Capital Cost View** from the **User Guide** for more information.

ShaftWork Model View

The Shaftwork Model is required when the product stream from the condenser needs to be cooled below the ambient temperature.

The Shaftwork Model view allows you to specify the parameters used to calculate the shaft work.

Figure 3.7



Refer to **Section 9.4.5 - Shaft Work Model** from **Reference Guide** for more information.

The following table lists and describes the objects available in the Shaftwork Model view:

Object	Description
Name field	Allows you to change the ShaftWork Model view title by entering a new name in the field.
Threshold Temperature field	Allows you to specify the threshold temperature. The default value is -20°C.
Ambient Temperature field	Allows you to specify the ambient temperature. The default value is 25°C.
Carnot Cycle Efficiency field	Allows you to specify the efficiency of the Carnot cycle. The default value is 0.75.
Notes group	Allows you to enter information regarding the settings of the shaftwork model.

When the product stream is below the ambient temperature, the shaft work value is calculated.

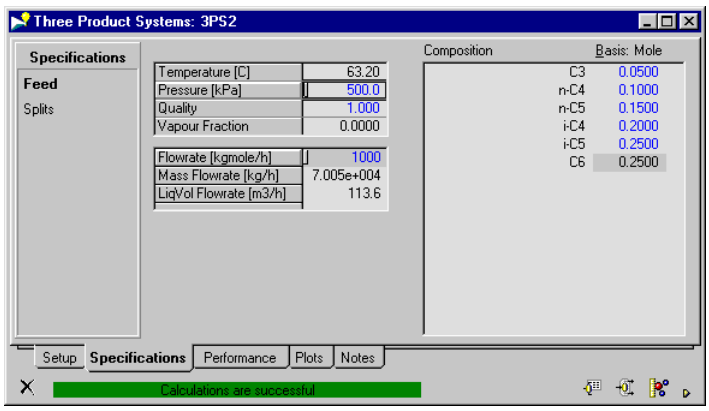
3.2.2 Specifications Tab

The Specifications tab is divided into two pages: Feed and Splits.

Feed Page

The Feed page allows you to manipulate the feed stream.

Figure 3.8



The following table lists and describes the objects available in the Feed page:

Object	Description
Temperature cell	Allows you to specify the temperature of the feed stream.
Pressure cell	Allows you to specify the pressure of the feed stream
Quality cell	Allows you to specify the quality of the feed stream. The default value is 1.
Vapour Fraction cell	Displays the vapour fraction of the feed stream. The feed stream will always be in pure liquid phase, so the vapour fraction value is always 0.
Flowrate cell	Allows you to specify the flowrate of the feed stream. The default value is 1000 kgmole/h.
Mass Flowrate cell	Displays the feed stream flow rate in terms of mass.
LiqVol Flowrate cell	Displays the feed stream flow rate in terms of liquid volume.
Composition table	Displays all the components available in the feed stream. You can specify the composition of the feed stream by entering the fraction value in the appropriate cells.

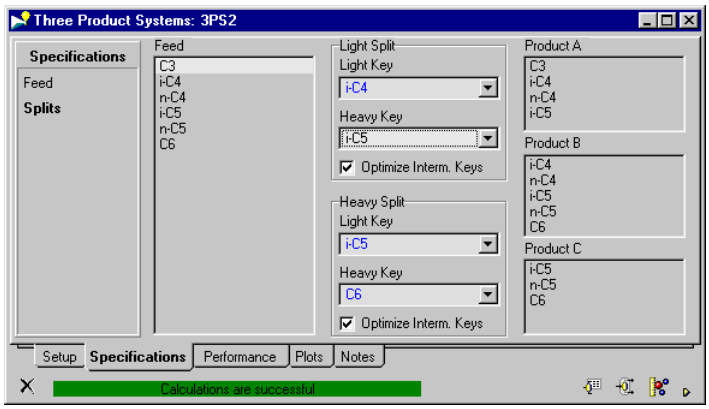
You can specify either the temperature or pressure of the feed stream, but not both.

You can specify the flow rate in mole basis only, but DISTIL can display the flow rate in different basis.

Splits Page

The Splits page allows you to specify the key components in the light and heavy splits.

Figure 3.9



The following table lists and describes the objects available in the Splits page:

Object	Description
Feed list	Displays all the components available in the feed stream.
Light Split group	Contains the options used to specify the components that will exit the column in the Product A stream. The Product A stream is also the light split stream. • The Light Split drop-down list allows you to select the “light key” component for the Product A stream. The selected component will be the second last heaviest component allowed in the stream. • The Heavy Split drop-down list allows you to select the “heavy key” component for the Product A stream. The selected component will be the last heaviest component allowed in the stream. The amount of the last component will be small compared to the amount of component selected in the Light Split drop-down list. • The Optimize Interm. Key checkbox allows you to toggle between optimizing or not optimizing the composition fraction of the other components in the product stream. If you want a certain fraction of intermediate components in a product stream, you have to uncheck this checkbox and specify the fraction you want in the **Recovery Matrix View**.
Heavy Split group	Contains the options used to specify the components that will exit the column in the Product C stream. The Product C stream is also the heavy split stream. • The Light Key drop-down list allows you to select the “light key” component for the Product C stream. The selected component will be the lightest component allowed in the stream. • The Heavy Key drop-down list allows you to select the “heavy key” component for the Product C stream. The selected component will be the heaviest component allowed in the stream. • The Optimize Interm. Key checkbox allows you to toggle between optimizing or not optimizing the composition fraction of the other components in the product stream. If you want a certain fraction of intermediate components in a product stream, you have to uncheck this checkbox and specify the fraction you want in the **Recovery Matrix View**.
Product A list	Displays the components in the Product A stream based on the column designs.
Product B list	Displays the components in the Product B stream based on the column designs.
Product C list	Displays the components in the Product C stream based on the column designs.

Intermediate components are components that falls between the specified light key and heavy key components.

3.2.3 Performance Tab

The Performance tab is divided into four pages: Summary, Utilities, Vapour Flows, and Shaftwork.

The names of the complex column configurations listed in the four pages allows you to access/open the configuration's individual view. Refer to the following **Complex Column Configuration View** section for more information.

Complex Column Configuration View

The individual complex column configuration view contains the same information as the Complex Column view for the selected configuration.

To access the individual complex column configuration view, double-click on the configuration's name in the Configuration column.

The differences between the Complex Column view and individual complex column configuration view are as follows:

- The individual complex column configuration view does not contain the following two tabs: **Setup** and **Specifications**.
- The **Performance** tab has an extra page called **Options**. The **Options** page contains options that were in the Complex Column view, but not in the Three Product System view.
- The Individual complex column configuration view does not contain the **Delete** icon.
- The **Recovery Matrix** icon on the individual complex column configuration view opens a Recovery Matrix view that does not allow you to make any changes. If you want to make changes, click the **Recovery Matrix** icon on the Three Product System view.

Delete icon

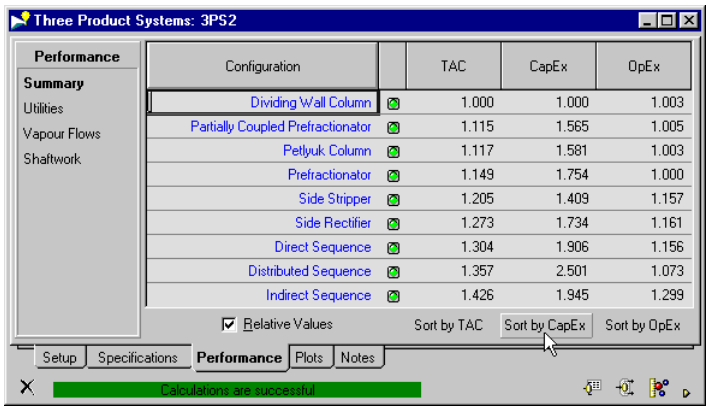
Recovery Matrix icon

Refer to **Chapter 2 - Complex Column** for more information about the complex column configuration view.

Summary Page

The Summary page displays a table that contains the name of all the complex column configurations selected and the summary of configuration's cost.

Figure 3.10



To sort the view by TAC, CapEx or OpEx values, click the appropriate text button below the table.

The following table lists and describes the objects available in the Summary page:

Object	Description
Configuration column	Allows you to access the individual configuration view. Refer to the **Complex Column Configuration View** section for more information.
Feasible Design icon	Displays whether the complex column configuration is feasible or not based on the information provided.
TAC column	Displays the total annual cost of the selected column configuration.
CapEx column	Displays the capital expenditure of the selected column configuration.
OpEx column	Displays the operation expenditure of the selected column configuration.
Relative Values checkbox	Allows you to toggle between displaying the actual values or the relative values in the table. The relative values are based on the lowest TAC, CapEx, and OpEx values.

The green icon indicates that the column design was successful.

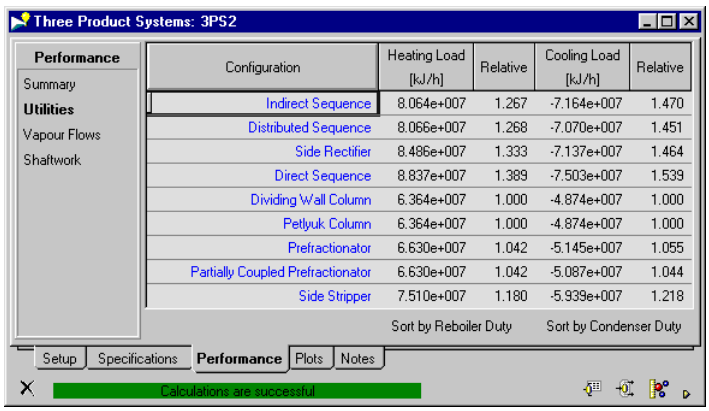
The red icon indicates that the column design was not successful.

Object	Description
Sort by TAC button	Allows you to sort the information in the Summary table by ascending TAC values.
Sort by CapEx button	Allows you to sort the information in the Summary table by ascending CapEx values.
Sort by OpEx button	Allows you to sort the information in the Summary table by ascending OpEx values.

Utilities Page

The Utilities page displays the duty required by the utilities in the complex column configuration.

Figure 3.11



To sort by reboiler or condenser duty, click the appropriate text button below the table.

The following table lists and describes the objects available in the Utilities page:

Object	Description
Configuration column	Allows you to access the individual configuration view.Double-click the view name to open the configuration view.
Heating Load column	Displays the heating duty of the utilities for the column configuration.
Relative column	Displays the relative values of the heating duty. The relative values are based on the lowest heating duty value.
Cooling Load column	Displays the cooling duty of the utilities for the column configuration.
Relative column	Displays the relative values of the cooling duty. The relative values are based on the lowest cooling duty value.

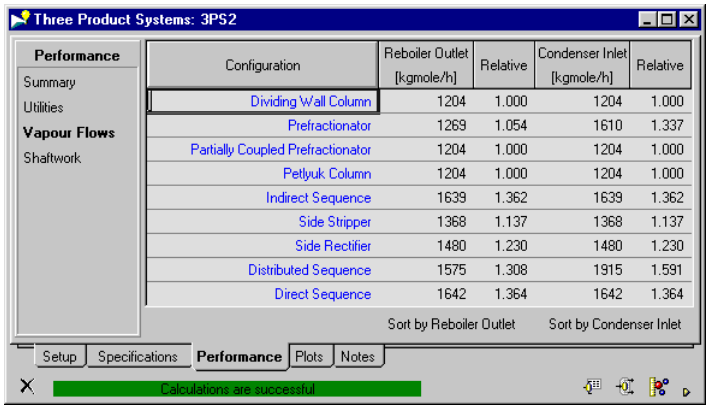
Refer to the **Complex Column Configuration View** section for more information.

Object	Description
Sort by Reboiler Duty button	Allows you to sort the information in the Utilities table by ascending heating duty values.
Sort by Condenser Duty button	Allows you to sort the information in the Utilities table by ascending cooling duty values.

Vapour Flows Page

The Vapour Flows page displays the vapour flow rate between the utilities and the column.

Figure 3.12



To sort by reboiler outlet or condenser inlet, click the appropriate text button below the table.

The following table lists and describes the objects available in the Vapour Flows page:

Refer to the **Complex Column Configuration View** section for more information.

Object	Description
Configuration column	Allows you to access the individual configuration view. Double-click the view name to open the configuration view.
Reboiler Outlet column	Displays the amount of vapour flowing from the reboiler(s) into the column(s).
Relative column	Displays the relative values of the vapour flow rate. The relative values are based on the lowest reboiler vapour flow rate value.
Condenser Inlet column	Displays the amount of vapour flowing from the column(s) into the condenser(s).
Relative column	Displays the relative values of the vapour flow rate. The relative values are based on the lowest condenser vapour flow rate value.

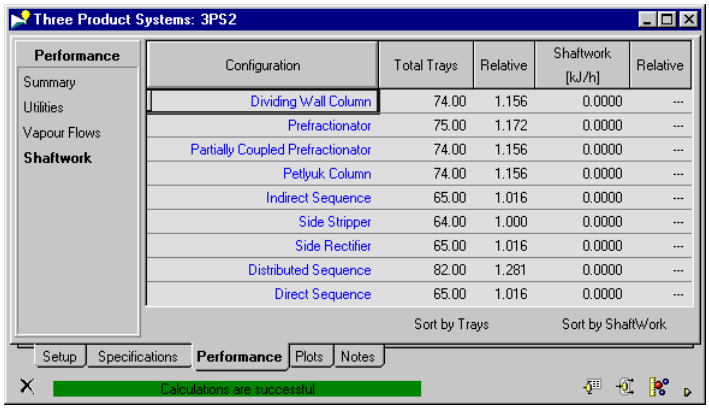
Object	Description
Sort by Reboiler Outlet button	Allows you to sort the information in the Vapour Flows table by ascending reboiler vapour flow rate values.
Sort by Condenser Inlet button	Allows you to sort the information in the Vapour Flows table by ascending condenser vapour flow rate values.

Shaftwork Page

The Shaftwork page displays the total number of trays and shaftwork value for all the selected complex column designs.

To sort by trays or by shaftwork, click the appropriate text button below the table.

Figure 3.13



The following table lists and describes the objects available in the Shaftwork page:

Refer to the **Complex Column Configuration View** section for more information.

Object	Description
Configuration column	Allows you to access the individual configuration view. Double-click the view name to open the configuration view.
Total Trays column	Displays the total amount of trays in the column configuration.
Relative column	Displays the relative values of the number of trays. The relative values are based on the lowest number of trays.
Shaftwork column	Displays the shaftwork value for the associated complex column. Refer to the **ShaftWork Model View** section in **Section 3.2.1 - Setup Tab** for more information.
Relative column	Displays the relative values of the shaftwork. The relative values are based on the lowest shaftwork value.

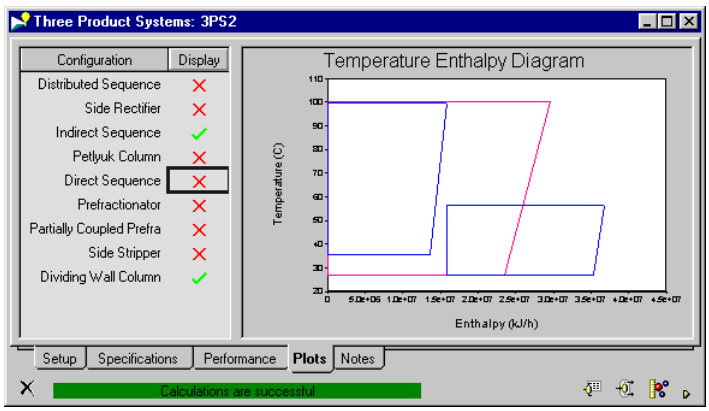
Object	Description
Sort by Trays button	Allows you to sort the information in the Shaftwork table by the number of trays.
Sort by Shaftwork button	Allows you to sort the information in the Shaftwork table by ascending shaftwork duty values.

3.2.4 Plots Tab

For information on manipulating plots, refer to **Section 7.4 - Plot Area** and **Chapter 8 - Plot Properties** in the **User Guide**.

The Plots tab contains the temperature vs. enthalpy plot for all the complex column configurations.

Figure 3.14



The checkboxes in the Display column are deactivated by default.

Green checkmark

Red cross

A red cross in the Display column means the plot for the associated configuration is hidden. A green checkmark in the Display column means the plot for the associated configuration appears in the diagram.

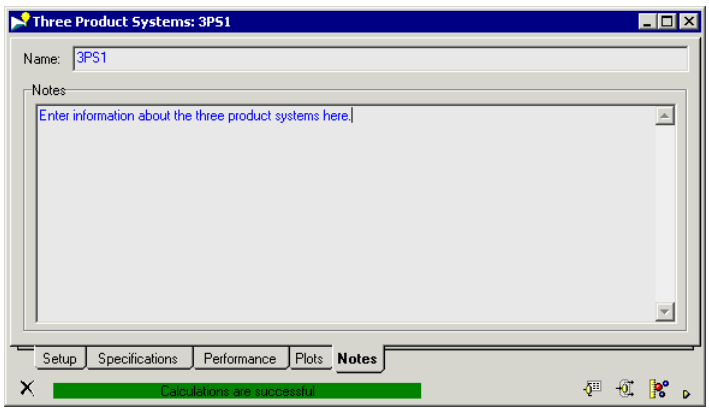
3.2.5 Notes Tab

The Notes tab allows you to:

- Change the name of the operation by entering a new name in the **Name** field. The new name will appear in the title bar of the operation view.
- Enter information regarding the operation in the **Notes** text editor.

Any changes made to the information in the Notes text editor will appear in the text editor located at the bottom of the Separation Manager view when the Show Notes button has been clicked.

Figure 3.15



4 Simple Column

4.1 Introduction

The Simple Column operation uses the same short-cut model that complex columns employ. Refer to **Section 5.3.5 - Modeling of Complex Columns** in the **Reference Guide**.

The Simple Column operation provides a framework to design and analyze simple column (i.e., a column with one feed stream, two products streams, one condenser, and one reboiler).

When you supply the feed stream and product specs, DISTIL performs all necessary calculations and provides all the details of the design, including the number of trays, feed tray location, duties, and vapour/liquid traffic.

The Simple Column operation also provides some additional features to retrofit a column and optimize column pressure.

- Refer to **Section 5.2.3 - Optimising Column Pressure** and **Section 5.2.4 - Column Retrofit Options** from the **Reference Guide** for the theory behind the additional features to retrofit a column.
- Refer to the **Retrofit Page** section in **Section 4.2.1 - Setup Tab** for more information on the retrofit options available in the Simple Column operation.

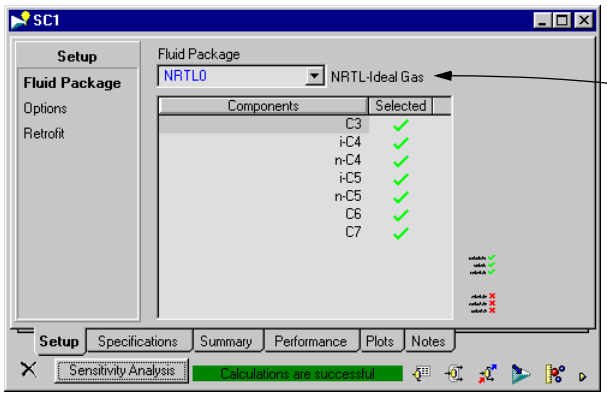
4.2 Simple Column View

To access previously created Simple Column operations, refer to **Section 1.2.2 - Editing an Operation**.

To create a Simple Column operation, do one of the following:

- From the **Features** menu, select **Simple Column Design**.
- From the **Managers** menu, select **Separation Manager.** The manager view appears. From the left list, select **SimpleColumn**, then click the **Add** button.

Figure 4.1



The Simple Column view contains six tabs: Setup, Specification, Summary, Performance, Plots, and Notes.

The view also contains nine objects located at the bottom of the view. The following table lists and describes the objects available in the Simple Column view:

Object	Icon	Description
Delete icon		Allows you to delete the current Simple Column operation.
Sensitivity Analysis button		Allows you to access the Sensitivity Analysis view. Refer to the **Sensitivity Analysis View** section for more information.
Status bar		Displays the status of the current Simple Column operation.
Recovery Matrix icon		Allows you access to the Recovery Matrix view. Refer to the **Recovery Matrix View** section for more information.
Mass Balance icon		Allows you access to the Mass Balance view. Refer to the **Mass Balance View** section for more information.

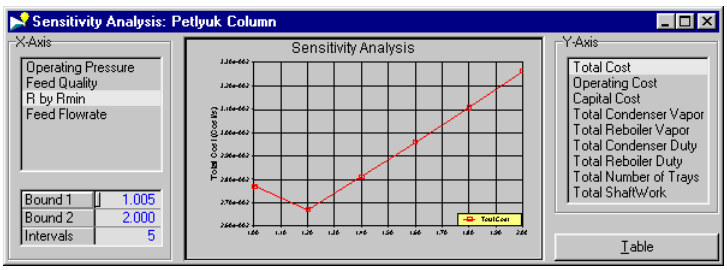
The status bar at the bottom of the view indicates what information is required before the operation can generate results.

Object	Icon	Description
Energy Balance icon		Allows you access to the Energy Balance view. Refer to the **Energy Balance View** section for more information.
Simulate icon		Allows you to export the column design into HYSYS for a more rigorous simulation. Refer to **Section 4.3 - Simulating in HYSYS** in the **Azeotropic Separation Manager** manual for more information.
() Fraction Basis icon		Allows you to access the Basis Selection view. Refer to the **Basis Selection View** section for more information.
Opens Current Page in Separate Window icon		Allows you to open the active tab as a separate view.

Sensitivity Analysis View

The Sensitivity Analysis view provides values of performance parameters when the input value is varied.

Figure 4.2



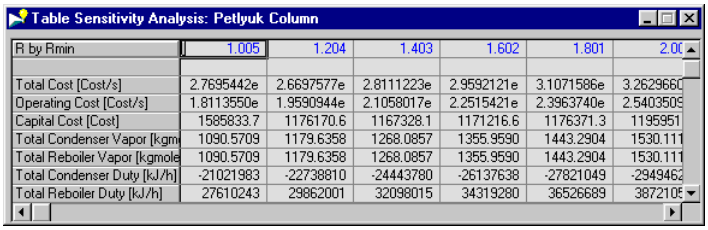
The completed design/ converged complex column acts as a base case for the sensitivity analysis.

To access the Sensitivity Analysis view:

1. Ensure you must have a completed column.
   For completed designs, the status bar has a green background and displays the message **Calculations are successful**.
2. Click the **Sensitivity Analysis** button.

The following table lists and describes the objects available in the Sensitivity Analysis view:

Object	Description
X-Axis list	Allows you to select the manipulated variable you want to place on the x-axis of the plot. The x-axis variable is the independent variable you manipulate to observe the changes in the complex column's performance.
Bound 1 cell	Allows you to specify the lowest/minimum value for the x-axis variable.
Bound 2 cell	Allows you to specify the highest/maximum value for the x-axis variable.
Intervals cell	Allows you to specify how many data points/values should be used to calculated the data results.
Sensitivity Analysis plot	Displays the calculated results in a plot format.
Y-Axis list	Allows you to select the performance indicator variable you want to place on the y-axis of the plot. The y-axis variable is the dependent variable that changes according to the x-axis variable value.
Table button	Allows you to access the Table Sensitivity Analysis view. This view displays the calculated dependent variable results in table format.



The first row in the Table Sensitivity Analysis view contains the independent variable. You can change the values of the variable by clicking in the cell and entering the new value.

The completed design/ converged complex column acts as a base case for the sensitivity analysis.

The following table contains the list of independent variables available for the sensitivity analysis feature and the default values:

Variables	Default Bound 1	Default Bound 2
Operating Pressure	0.5 * base case pressure	1.5 * base case pressure
Feed quality	0	1
R/R_{min}	1.05	2
Feed flowrate	0.5 * base case flow rate	1.5 * base case flow rate

The following table lists and describes of output/performance indicator variables available for the sensitivity analysis feature:

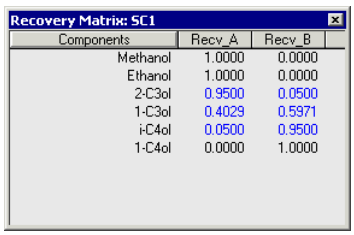
Variable	Description
Total Cost	The sum of total annual cost for all columns and heat exchangers in the design.
Operating Cost	The sum of operating costs for all heat exchangers in the design.
Capital Cost	The sum of capital costs for all columns and heat exchangers in the design.
Total Condenser Vapour	The total vapour from all the condensers in the design.
Total Reboiler Vapour	The total vapour from all the reboilers in the design.
Total Condenser Duty	The total duty from all the condensers in the design.
Total Reboiler Duty	The total duty from all the reboilers in the design.
Total Number of Trays	The total number of trays from all the columns in the design.
Total Shaftwork	The total shaftwork from all the refrigerant in the design.

Recovery Matrix View

For more information about the purpose of the Recovery Matrix, refer to **Section 5.3.3 - Specification of Three Product System** in the **Reference Guide**.

The Recovery Matrix view displays the fractional recovery of components in each product stream.

Figure 4.3



Recovery Matrix icon

To access the Recovery Matrix view, click the Recovery Matrix icon. The table will be blank unless you have a completed column design. For completed designs, the status bar has a green background and displays the message **Calculations are successful**.

Blue text indicates where you can change the composition fraction in the Recovery Matrix view.

The *** text indicates that the value is the optimized value. To change optimized values, uncheck the Optimize Interm. Key checkbox (Specifications tab, Splits page).

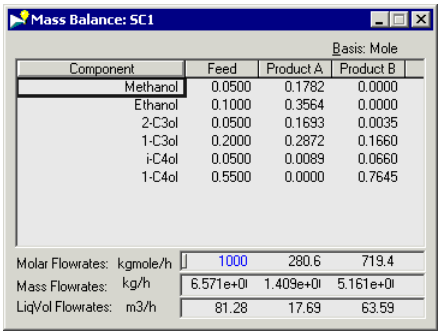
Mass Balance View

You cannot change the values displayed in black text.

You can change the feed flow rate in the Feed cell at the bottom, or in the Specifications tab, Feed page of the operation view.

The Mass Balance view displays the mass flow rate of the components in each product stream in a table format.

Figure 4.4



Mass Balance icon

To access the Mass Balance view, click the Mass Balance icon. The table will be blank unless you have a completed column design. For completed designs, the status bar has a green background and displays the message **Calculations are successful**.

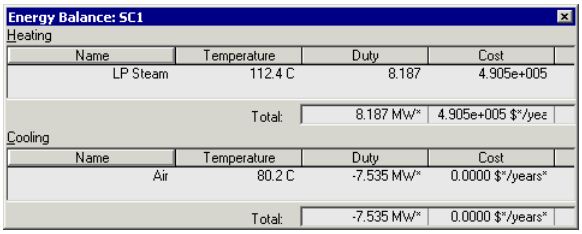
Energy Balance View

You cannot change the values displayed in black text.

You can change the utility type in the Performance tab, Op. Conditions page of the operation view.

The Energy Balance view displays the utility type, temperature, duty, and cost of the condensers and reboilers in the operation.

Figure 4.5



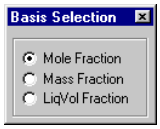
Energy Balance icon

To access the Energy Balance view, click the Energy Balance icon. The table will be blank unless you have a completed column design. For completed designs, the status bar has a green background and displays the message **Calculations are successful**.

Basis Selection View

The Basis Selection view allows you to change the composition basis fraction type displayed in the operation view.

Figure 4.6



Molar Fraction Basis icon

Mass Fraction Basis icon

Volume Faction Basis icon

To change the composition basis using the Basis Selection view:

1. Click on the **Molar/Mass/Volume Fraction Basis** icon to open the Basis Selection view.
2. Use the radio buttons to select the composition basis you want to display in the operation view.
   The fraction basis icon on the operation view changes according to your selection.
3. Click the **Close** icon ✕ when you are done.

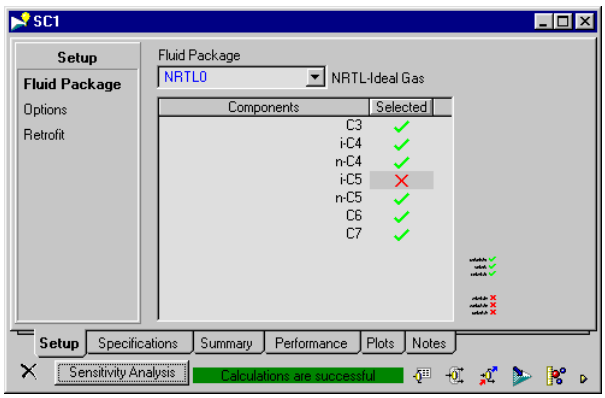
4.2.1 Setup Tab

The Setup tab is divided into three pages: Fluid Package, Options, and Retrofit.

Fluid Package Page

The Fluid Package page allows you to select the fluid package and components of the feed stream entering the column.

Figure 4.7



The following table lists and describes the objects available in the Fluid Package page:

Object	Icon	Description
Fluid Package drop-down list		Allows you to select the fluid package for the feed stream.
Components column		Displays all the components in the selected fluid package.
Selected column		Allows you to toggle the selection status of the components by clicking the icon in the column.
Unselect All Components icon		Allows you to deselect all the components in the fluid package.
Select All Components icon		Allows you to select all the components in the fluid package.

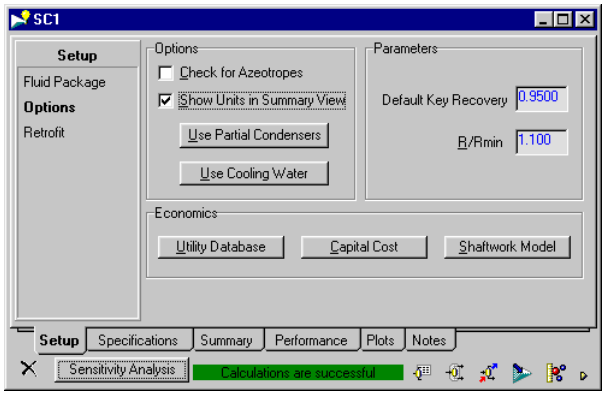
A green checkmark indicates that the component is selected.

A red cross indicates that the component is not selected.

Options Page

The Options page allows you to manipulate the configuration of the column.

Figure 4.8



The following table lists and describes the objects that are available in the Options page.

Object	Description
Check for Azeotropes checkbox	Allows you to toggle between checking or not checking for azeotropes when designing/calculating the column.
Show Units in Summary View checkbox	Allows you to toggle between displaying or hiding the units on the figure in the Summary tab.
Use Partial Condenser button	Allows you to use partial condensers for the column.
Use Cooling Water button	Allows you to use cooling water for the condenser.
Default Key Recovery field	Displays the recovery fraction of light and heavy key component. The default value is 0.95.
R/Rmin field	Allows you to specify the ratio between the reflux and the minimum reflux. The default value is 1.10.
Utility Database button	Allows you to access the Utility Database view. This view displays the information about all the utilities available in DISTIL.
Capital Cost button	Allows you to access the Capital Cost view. This view contains the options used to calculate the size and cost of the column.
Shaftwork Model button	Allows you to access the ShaftWork Model view. Refer to the **ShaftWork Model View** section for more information.

Refer to **Section 10.2 - Utility Database View** in the **User Guide** for more information.

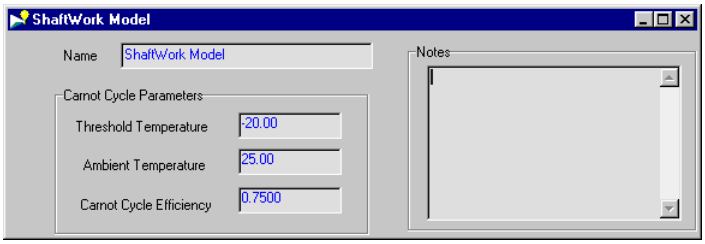
Refer to **Section 10.1 - Capital Cost View** in the **User Guide** for more information.

ShaftWork Model View

The ShaftWork Model is required when the product stream (from the condenser) needs to be cooled below the ambient temperature.

The ShaftWork Model view allows you to specify the parameters used to calculate the shaft work.

Figure 4.9



Refer to **Section 9.4.5 - Shaft Work Model** from **Reference Guide** for more information.

The following table lists and describes the objects available in the ShaftWork Model view:

When the product stream is below the ambient temperature, the shaft work value is calculated.

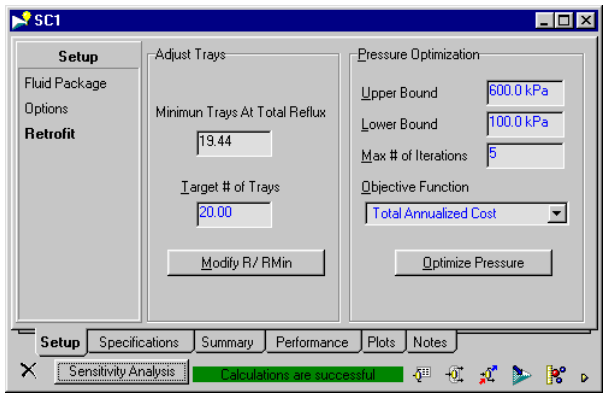
Object	Description
Name field	Allows you to change the ShaftWork Model view title by entering a new name in the field.
Threshold Temperature field	Allows you to specify the threshold temperature. The default value is -20°C.
Ambient Temperature field	Allows you to specify the ambient temperature. The default value is 25°C.
Carnot Cycle Efficiency field	Allows you to specify the efficiency of the Carnot cycle. The default value is 0.75.
Notes group	Allows you to enter information regarding the settings of the shaftwork model.

Retrofit Page

You can use the options in the Retrofit page only after you have successfully completed the column design.

The Retrofit page allows you to design the column based on the number of trays instead of the reflux, and to optimize the column's pressure to minimize the cost, vapour load, duty, or shaft work.

Figure 4.10



The following table lists and describes the objects available in the Retrofit page:

You must specify the number of trays value to be more than the minimum number of trays at total reflux.

Object	Description
Minimum Trays At Total Reflux field	Displays the minimum number of trays at total reflux for the current column design.
Target # of Trays	Allows you to specify the fixed number of trays the column contains.
Modify R/Rmin button	Allows you to begin modification of the reflux ratio based on the fixed number of trays you specified.
Upper Bound field	Allows you to specify the maximum pressure allowed in the column.
Lower Bound field	Allows you to specify the minimum pressure allowed in the column.
Max # of Iterations field	Allows you to specify the maximum number of iterations allowed in the calculation.
Objective Function drop-down list	Allows you to select the variable that is set to the minimum value to generate the optimum pressure.
Optimize Pressure button	Allows you to begin modification of the optimized pressure based on the selected variable in the Objective Function drop-down list.

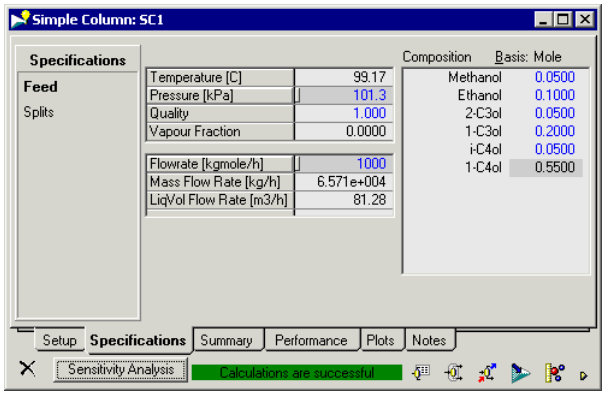
4.2.2 Specifications Tab

The Specifications tab is divided into two pages: Feed and Splits.

Feed Page

The Feed page allows you to manipulate the feed stream.

Figure 4.11



The following table lists and describes the objects available in the Feed page:

Object	Description
Temperature cell	Allows you to specify the temperature of the feed stream.
Pressure cell	Allows you to specify the pressure of the feed stream
Quality cell	Allows you to specify the quality of the feed stream. The default value is 1.
Vapour Fraction cell	Displays the vapour fraction of the feed stream. The feed stream will always be in pure liquid phase, so the vapour fraction value is always 0.
Flowrate cell	Allows you to specify the flow rate of the feed stream. The default value is 1000 kgmole/h.
Mass Flow Rate cell	Displays the feed stream flow rate in terms of mass.
LiqVol Flow Rate cell	Displays the feed stream flow rate in terms of liquid volume.
Composition table	Displays all the components available in the feed stream. You can specify the composition of the feed stream by entering the fraction value in the appropriate cells.

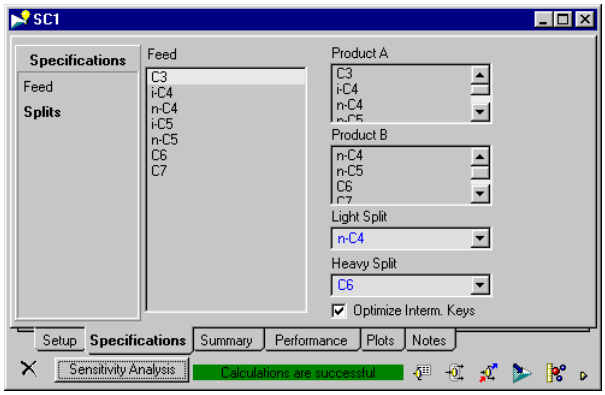
You can specify either the temperature or pressure of the feed stream, but not both.

You can specify the flow rate in mole basis only, but DISTIL can display the flow rate at different basis.

Splits Page

The Splits page allows you to specify the key components in the light and heavy splits.

Figure 4.12



The following table lists and describes the objects available in the Splits page:

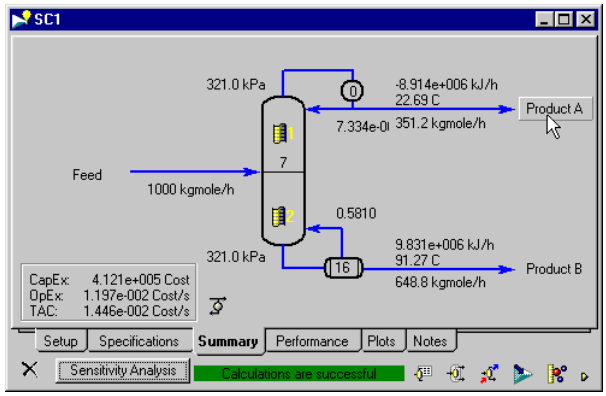
Object	Description
Feed list	Displays all the components available in the feed stream.
Product A list	Displays all the components available in the Product A stream. This list is empty when the column design is not complete.
Product B list	Displays all the components available in the Product B stream. This list is empty when the column design is not complete.
Light Split drop-down list	Allows you to select the “light key” component for the Product A stream. The selected component will be the second last heaviest component allowed in the stream.
Heavy Split drop-down list	Allows you to select the “heavy key” component for the Product C stream. Any components heavier than the selected component will also be allowed in the stream.
Optimize Interm. Keys checkbox	Allows you to toggle between optimizing or not optimizing the composition fraction of the other components in the product stream. If you want a certain fraction of intermediate components in a product stream, uncheck this checkbox and specify the fraction you want in the **Recovery Matrix View**.

Intermediate components are components that falls between the specified light key and heavy key components.

4.2.3 Summary Tab

The Summary tab contains a figure that represents the simple column configuration and its connectivity with all flowrates, temperatures, pressures, and duties.

Figure 4.13



To access more detailed information about the streams and sections in the column design, move the mouse pointer over the name of the object and click the button that appears. In the figure above, the mouse pointer has activated the Product A button for Product A stream.

The following table lists and describes the objects available in the Summary tab:

Object	Icon	Description
Feed button		Allows you to access the Feed Stream view. Refer to the **Stream Details View** section for more information.
Section Details icon		Allows you to access the Section view. The Section view contains detail information about the selected section. Refer to the **Section Details View** section for more information. The number below the icon indicates the tray number in which the section ends.
Condenser icon		Displays the tray number of the stream that enters the condenser.
Reboiler icon		Displays the tray number of the stream that enters the reboiler.

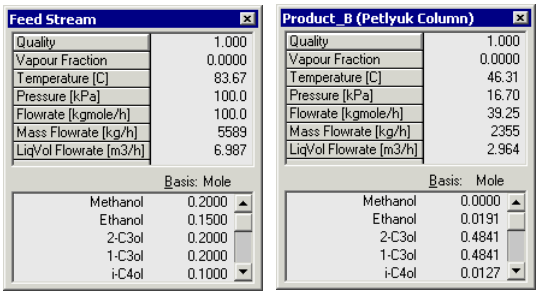
Object	Icon	Description
Change Column Condenser to Partial/Total		Allows you to toggle between setting the condenser of the column to a partial or a total condenser.
Product A button		Allows you to access the Product A stream view.
Product B button		Allows you to access the Product B stream view.
Summary group		Displays the capital expenditure, operation expenditure, and the total annual cost (TAC) values for the column design.

Refer to the **Stream Details View** section for more information about the Product stream view.

Stream Details View

The Feed Stream and Product Stream views display detailed information about the selected stream. You cannot modify any information in these views.

Figure 4.14



To access the Feed Stream details view:

1. Ensure that you have a complete column design.
   For complete column designs, the status bar has a green background and displays the message **Calculations are successful**.
2. Click the **Summary** tab.
3. Move the mouse pointer over the stream's name. The **Feed/Product Details** button will appear.
4. Click the **Feed/Product Details** button. The Stream Details view about the selected stream will appear.

Section Details View

The variables that can be changed are indicated by the blue colour text.

The "---" beside a variable indicates that no value have been specified for that variable.

The Section Details view displays detailed information about the selected section. You can modify some of the variables in the view.

Figure 4.15

Section 2 (SC1)	
Top Pressure [kPa]	101.3
Bottom Pressure [kPa]	101.3
Pressure Drop [kPa]	0.0000
Top Temperature [C]	---
Bottom Temperature [C]	112.4
Duty [MW*]	8.187
Vapour Flow [kgmole/h]	682.1
Liquid Flow [kgmole/h]	1402
Number of Trays	11
Height [m]	7.706
Diameter [m]	2.680
Utility Used	LP Steam

The variables that you can change are:

- Top Pressure
- Bottom Pressure
- Pressure Drop
- Top Temperature
- Bottom Temperature

To access the Section Details view:

1. Ensure that you have a complete column design. For complete designs, the status bar background is green and displays the message **Calculations are successful**.
2. Click the **Summary** tab.
3. Move the mouse pointer over the section in the column that you want to observe. The **Section Details** icon will appear.
4. Click the **Section Details** icon. The Section Details view about the selected section will appear.

Section Details icon of the 2nd section in a column

4.2.4 Performance Tab

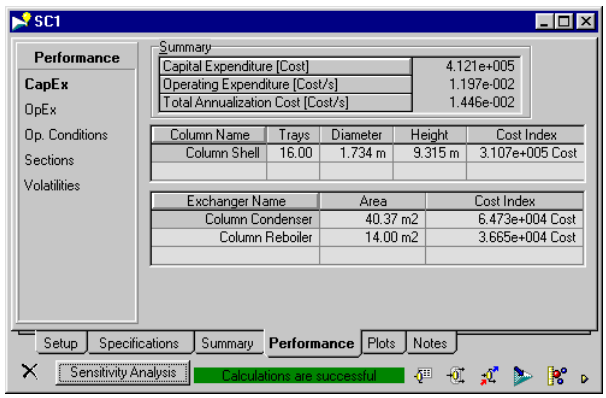
The Performance tab is split into five pages: CapEx, OpEx, Op. Conditions, Sections, and Volatilities.

CapEx Page

For more information about the capital cost refer to **Chapter 10 - Sizing and Costing** in the **User Guide.**

The CapEx page displays all capital cost information for the simple column configuration, including column shells and heat exchangers (condensers and reboilers).You cannot edit the information on this page.

Figure 4.16

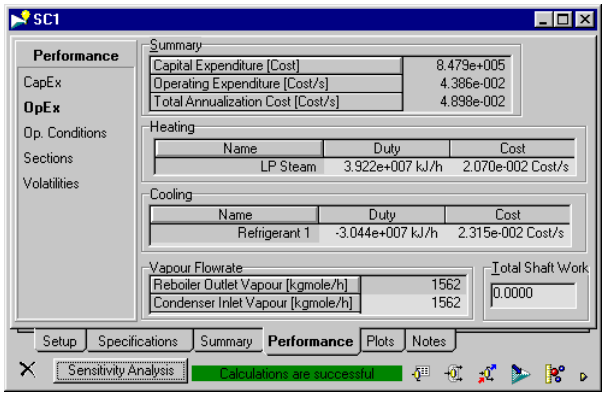


OpEx Page

For more information about the operating cost refer to **Chapter 10 - Sizing and Costing** in the **User Guide.**

The OpEx page displays all the operating cost information regarding the simple column configuration.You cannot edit the information on this page.

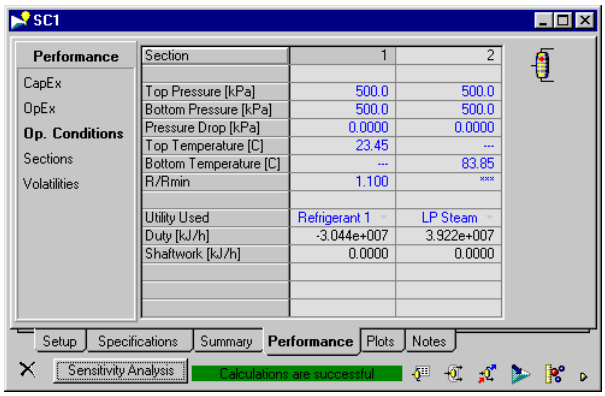
Figure 4.17



Op. Conditions Page

The Op. Conditions page allows you to manipulate the operating conditions in each section of the column(s).

Figure 4.18



The icon on the right side of the table displays a red dot that indicates which section you have selected in the table. In the figure above, the selected section is 1, and the red dot appears in section 1 on the column.

The following table lists and describes the objects available in the Op. Conditions page:

This **---** indicates that no value has been specified for that variable.

This ******* indicates that the variable value has been optimized. You cannot change this value, until you uncheck the Optimize Interm. Key checkbox (Specifications tab, Splits page).

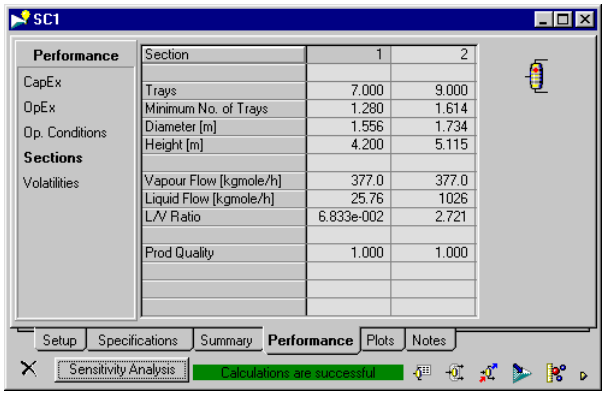
Object	Description
Section cell	Displays the section number.
Top Pressure cell	Allows you to specify the pressure at the top tray of the active section.
Bottom Pressure cell	Allows you to specify the pressure at the bottom tray of the active section.
Pressure Drop cell	Allows you to specify the pressure difference between the top and bottom tray of the active section.
Top Temperature cell	Allows you to specify the temperature at the top tray of the active section.
Bottom Temperature cell	Allows you to specify the temperature at the bottom tray of the active section.
R by Rmin Value cell	Allows you to specify the ratio of reflux/minimum reflux for the active section.
Utility Used cell	Allows you to select a different utility for the active section by accessing the drop-down list.
Duty cell	Displays the amount of energy per hour required for the selected utility.
ShaftWork cell	Displays the amount of energy per hour required by the shaftwork.

Refer to **Section 1.1.5 - Utility Selection for Condenser/Reboiler** for information on how DISTIL selects a utility.

Sections Page

The Sections page displays the configuration of each section in the complex column design. You cannot modify the values on this page.

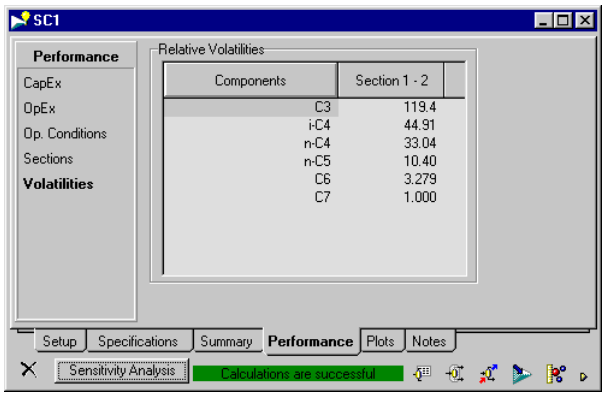
Figure 4.19



Volatilities Page

The Volatilities page displays the calculated relative volatility of each component at different sections in the column design. You cannot modify the values on this page.

Figure 4.20



The relative volatility values depend strongly on the pressure, temperature, and the composition of the mixture.

Relative volatility represents the ease of separation of a component in the mixture. It is defined using the least volatile component as the base (i.e., relative volatility of the heaviest component in the mixture is 1). So the higher the value of volatility, the easier it is to separate the components from the heaviest component using distillation.

For information on short-cut models, refer to **Section 4.4.1 - Shortcut Method** in the **Reference Guide**.

This information is useful for judging the assumptions of short-cut models (like Underwood and Winn's method). If the relative volatility values in different sections are significantly different, then the results of short-cut methods are less accurate.

DISTIL recommends you view the relative volatility values to see if the short-cut method is accurate or not.

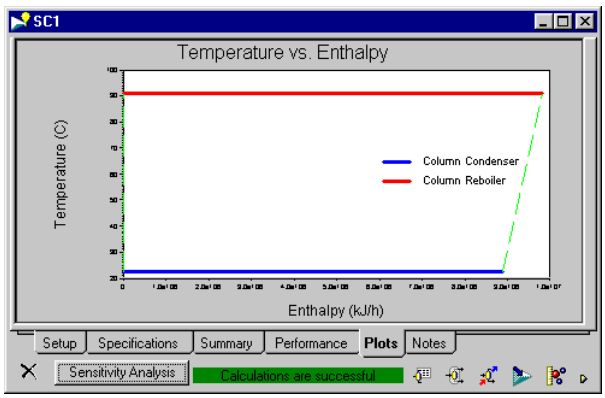
In all cases, the component order should not change with operating conditions such as pressure, temperature, and composition. If the order of decreasing volatility changes then the short-cut performance models are inappropriate for the selected system.

4.2.5 Plots Tab

For information on manipulating plots, refer to **Section 7.4 - Plot Area** and **Chapter 8 - Plot Properties** in the **User Guide**.

The Plots tab contains a temperature vs. enthalpy graph.

Figure 4.21



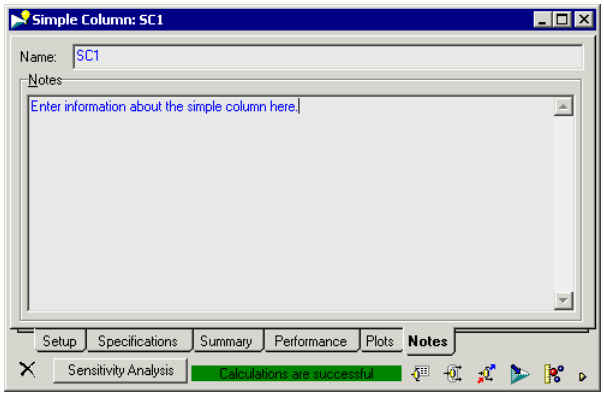
4.2.6 Notes Tab

The Notes tab allows you to:

- Change the name of the operation by entering a new name in the **Name** field. The new name will appear in the title bar on the operation view.
- Enter information regarding the operation in the **Notes** text editor.

Any changes made to the information in the Notes text editor will appear in the text editor located at the bottom of the Separation Manager view when the Show Notes button has been clicked.

Figure 4.22



5 Column Sequencing

5.1 Introduction

The Column Sequencing operation is used to identify feasible distillation sequences, which are used to separate a specified feed stream into several selected products. This operation also determines the number of stages, the feed tray location and the reflux ratio for each of the feasible distillation columns.

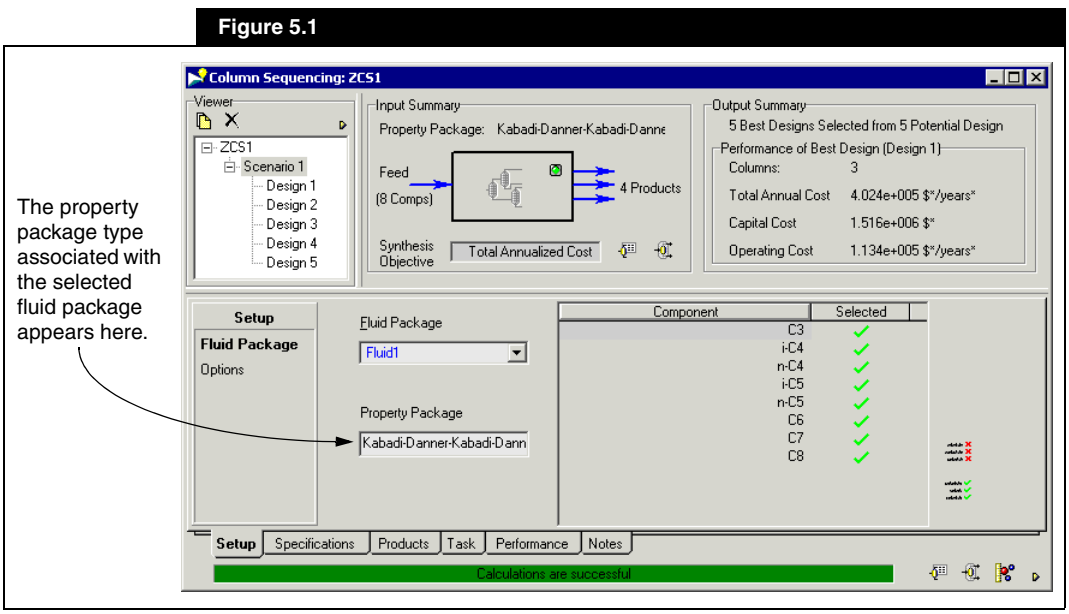
5.2 Column Sequencing View

To access previously created Column Sequencing operation, refer to **Section 1.2.2 - Editing an Operation**.

To create a Column Sequencing operation, do one of the following:

- From the **Features** menu, select **Column Sequencing** command.
- From the **Managers** menu, select **Separation Manager.** The manager view appears. In the left list, select **ColumnSequencing**, then click the **Add** button.

Figure 5.1



For more information about the project view, refer to **Section 2.3.5 - Project View** in the **User Guide**.

The Column Sequencing view is a project view. All project views have three levels: Project, Scenario, and Design. Each level contains different objects, tabs, and groups. The only group/object in the project view that stays constant is the Viewer group, which allows you to navigate from level to level.

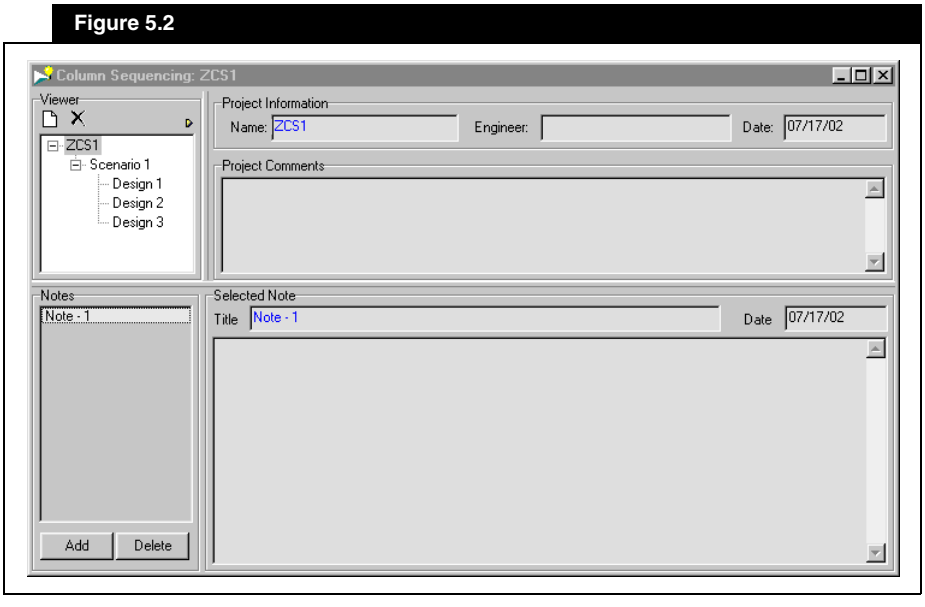
The following sections describe in detail what options/objects each level contains for the Column Sequencing view.

5.3 Project Level

For more information about the options at Project level, refer to **Section 2.3.5 - Project View** in the **User Guide**.

At the Project level, the project view is the same for all operations. The Project level allows you to enter general information about the operation.

Figure 5.2



Multiple Scenarios and Designs can exist in the Column Sequencing operation, but only one Project can exist in the operation.

You cannot add/clone/delete the Project in the operation.

5.3.1 Viewer Group

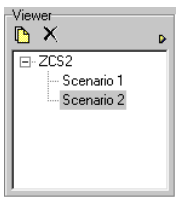
The objects in the Viewer group remain the same at all three levels of the project view.

The Viewer group allows you to navigate between levels in the project view and manipulate the levels. For more information on manipulating the levels, see **Section 7.5.1 - Viewer Pane** in the **User Guide**.

The following table lists and describes the objects available in the Viewer group:

Name	Icon	Description
Add Scenario		Allows you to add a scenario to the project. Available only at the Project level.
Clone Scenario/ Design		Allows you to clone a selected scenario or design. Available at the Scenario and Design levels.
Delete Scenario/ Design		Allows you to delete the selected scenario or design.
Open Viewer as Separate Window		Allows you to open the Viewer group as a separate view.

5.4 Scenario Level



Viewer group

At Scenario level:

- One of the **Scenario** names must be selected in the Viewer group, as shown in the figure on the left.
- The Main (upper) pane allows you to manipulate composition and flow rate for the overall sequence feed stream.
- The Worksheet (lower) pane contains several tabs that allow you to manipulate the parameters of columns in the generated sequence.

The following table lists and describes the objects at the bottom of the Worksheet pane that are available on all the tabs:

The status bar at the bottom of the view also indicates what information is required before the operation can generate results.

Object	Icon	Description
Status bar		Displays the status of the current Simple Column operation.
Recovery Matrix icon		Allows you access to the Recovery Matrix view. Refer to the **Recovery Matrix View** section for more information.
Overall Mass Balance icon		Allows you access to the Mass Balance view. Refer to the **Mass Balance View** section for more information.

Object	Icon	Description
() Fraction Basis icon		Allows you to access the Basis Selection view. Refer to the **Basis Selection View** section for more information.
Opens Current Page in Separate Window icon		Allows you to open the active tab as a separate view.

Recovery Matrix View

For more information about the purpose of the Recovery Matrix, refer to **Section 5.3.3 - Specification of Three Product System** from the **Reference Guide**.

The Recovery Matrix view displays the fractional recovery of components in each product stream.

Figure 5.3

Scenario 1 - Recovery Matrix

	A	B	C	D
C3	0.9500	0.0500	0.0000	0.0000
i-C4	0.0010	0.9990	0.0000	0.0000
n-C4	0.0500	0.9000	0.0500	0.0000
i-C5	0.0000	0.0500	0.9500	0.0000
n-C5	0.0000	0.0000	0.9500	0.0500
H2O	0.0000	0.0000	0.0500	0.9500
C6	0.0000	0.0000	0.0000	1.0000

Recovery Matrix icon

To access the Recovery Matrix view, click the Recovery Matrix icon. The table in the view will be blank unless you have a completed column design. For completed designs, the status bar has a green background and displays the message **Calculations are successful**.

Blue text indicates where you can change the composition fraction of the intermediate components.

The *** text indicates that the value is the optimized value. To change the optimized values, uncheck the Optimize Interm. Key checkbox (Specifications tab, Splits page).

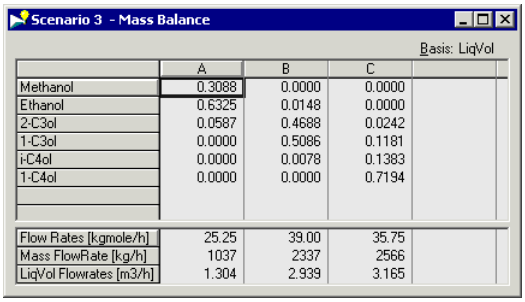
Mass Balance View

You cannot change the values displayed in black text.

You can change the feed flowrate in the Specifications tab, Feed page of the Column Sequencing view.

The Mass Balance view displays the mass flow rate of the components in each product stream in a table format.

Figure 5.4



	A	B	C
Methanol	0.3088	0.0000	0.0000
Ethanol	0.6325	0.0148	0.0000
2-C3ol	0.0587	0.4688	0.0242
1-C3ol	0.0000	0.5086	0.1181
i-C4ol	0.0000	0.0078	0.1383
1-C4ol	0.0000	0.0000	0.7194
Flow Rates [kgmole/h]	25.25	39.00	35.75
Mass FlowRate [kg/h]	1037	2337	2566
LiqVol Flowrates [m3/h]	1.304	2.939	3.165

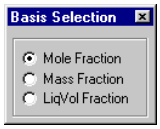
Overall Mass Balance icon

To access the Mass Balance view, click the Overall Mass Balance icon. The table in the view will be blank unless you have a completed column design. For completed designs, the status bar has a green background and displays the message **Calculations are successful**.

Basis Selection View

The Basis Selection view allows you to change the composition basis fraction type displayed in the operation view.

Figure 5.5



Molar Fraction Basis icon

Mass Fraction Basis icon

Liquid Volume Fraction Basis icon

To change the composition basis using the Basis Selection view:

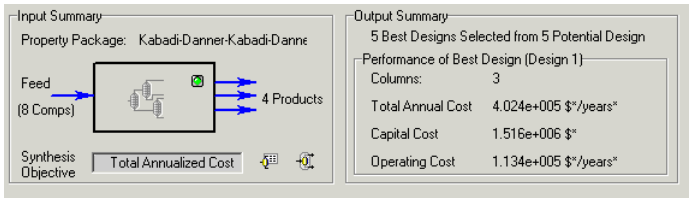
1. Click on the **Molar/Mass/Volume Fraction Basis** icon to open the Basis Selection view.
2. Use the radio buttons to select the composition basis you want to display in the operation view.
   The fraction basis icon on the operation view changes according to your selection.
3. Click the **Close** icon ✕ when you are done.

The following sections describe the tabs in the Simple Column view in detail.

5.4.1 Main Pane

The Main pane, located at the top right side of the view, is divided into two groups: Input Summary and Output Summary.

Figure 5.6



The following table lists and describes the objects available in the Main pane:

The Input Summary group will appear mostly blank until you specified the required information for the column sequencing. Refer to the following sections for more information.

Object	Icon	Description
Input Summary group		Displays the following information: • property package associated with the feed stream • number of components in the feed stream • number of product streams • the synthesis objective for the column sequence design
Press to generate feasibility column sequences icon		Allows you to generate feasible column sequences to separate the feed into the selected products. Available only when you have entered all required parameters.

Object	Icon	Description
Recovery Matrix icon		Allows you access to the Recovery Matrix view. For more information, refer to the **Recovery Matrix View** section.
Mass Balance icon		Allows you access to the Mass Balance view. For more information, refer to the **Mass Balance View** section.
Output Summary group		Displays the following information on the best design in the selected scenario: • name of the design • number of columns in the design • total annual cost • capital cost of the design • operating cost of the design

The Input Summary group will appear mostly blank until DISTIL has generated one or more column sequence design(s).

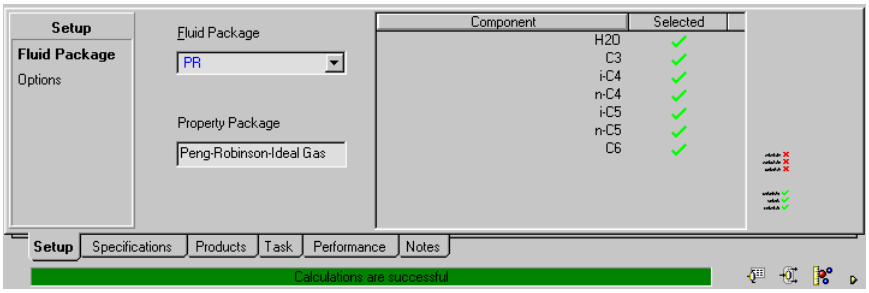
5.4.2 Setup Tab

The Setup tab is located in the Worksheet (lower) pane and is divided into two pages: Fluid Package and Options.

Fluid Package Page

The Fluid Package page allows you to select the fluid package and components for the feed stream.

Figure 5.7



The following table lists and describes the objects available in the Fluid Package page:

Object	Icon	Description
Fluid Package drop-down list		Allows you to select the fluid package for the feed stream.
Component column		Displays all the components in the selected fluid package.
Selected column		Allows you to toggle the selection status of the components by clicking the icon in the column.
Unselect All Components icon		Allows you to deselect all the components in the fluid package.
Select All Components icon		Allows you to select all the components in the fluid package.

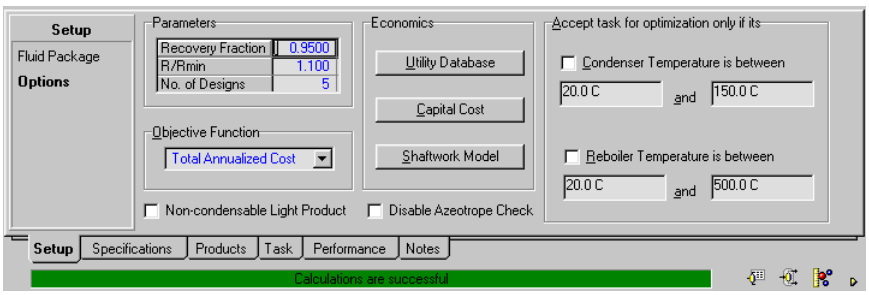
A green checkmark indicates that the component is selected.

A red cross indicates that the component is not selected.

Options Page

The Options page allows you to specify certain conditions for designing and calculating the column sequence.

Figure 5.8



The following table lists and describes the objects that are available in the Options page.

Object	Description
Recovery Fraction cell	Allows you to specify the recovery fraction of light and heavy key components. The default value is 0.95.
R/Rmin cell	Allows you to specify the ratio between the reflux and the minimum reflux. The default value is 1.10.
No. of Designs cell	Allows you to specify the maximum number of the best designs that will be kept in the scenario. The default value is 5.

DISTIL will keep the column sequence designs with the minimum value of the selected objective function.

Refer to **Section 10.2 - Utility Database View** from the **User Guide** for more information.

Refer to **Section 10.1 - Capital Cost View** from the **User Guide** for more information.

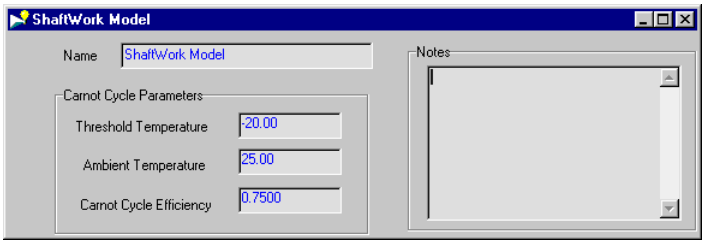
Object	Description
Objective Function drop-down list	Allows you to select the objective function of the column sequence calculation. The default selection is Total Annualized Cost.
Non-condensable Light Product checkbox	Allows you to toggle between allowing or not allowing a vapour product stream in the columns. Check to allow vapour products or uncheck to allow only liquid products.
Disable Azeotrope Check checkbox	Allows you to toggle between checking and not checking for azeotropes during the column sequencing calculations.
Utility Database button	Allows you to access the Utility Database view. This view displays the information about all the utilities available in DISTIL.
Capital Cost button	Allows you to access the Capital Cost view. This view contains the options used to calculate the size and cost of the column.
Shaftwork Model button	Allows you to access the ShaftWork Model view. Refer to the **ShaftWork Model View** section for more information.
Condenser Temperature is between checkbox	Allows you to toggle between performing or not performing the optimization when the condenser temperature is within the specified temperature range. When this checkbox is checked, the text in the fields below the checkbox becomes blue. This indicates you can specify the temperature range you want. • Specify the lowest temperature of the temperature range in the left field. • Specify the highest temperature of the temperature range in the right field.
Reboiler Temperature is between checkbox	Allows you to toggle between performing or not performing the optimization when the reboiler temperature is within the specified temperature range. When this checkbox is checked, the text in the fields below the checkbox becomes blue. This indicates you can specify the temperature range you want. • Specify the lowest temperature of the temperature range in the left field. • Specify the highest temperature of the temperature range in the right field.

ShaftWork Model View

The Shaftwork Model is required when the product stream from the condenser needs to be cooled below the ambient temperature.

The ShaftWork Model view allows you to specify the parameters used to calculate the shaft work.

Figure 5.9



The following table lists and describes the objects available in the ShaftWork Model view:

When the product stream is below the ambient temperature, the shaft work value is calculated.

Object	Description
Name field	Allows you to change the Shaftwork Model view title by entering a new name in the field.
Threshold Temperature field	Allows you to specify the threshold temperature. The default value is -20°C.
Ambient Temperature field	Allows you to specify the ambient temperature. The default value is 25°C.
Carnot Cycle Efficiency field	Allows you to specify the efficiency of the Carnot cycle. DISTIL default value is 0.75.
Notes group	Allows you to enter information regarding the settings of the shaftwork model.

Refer to **Section 9.4.5 - Shaft Work Model** from **Reference Guide** for more information.

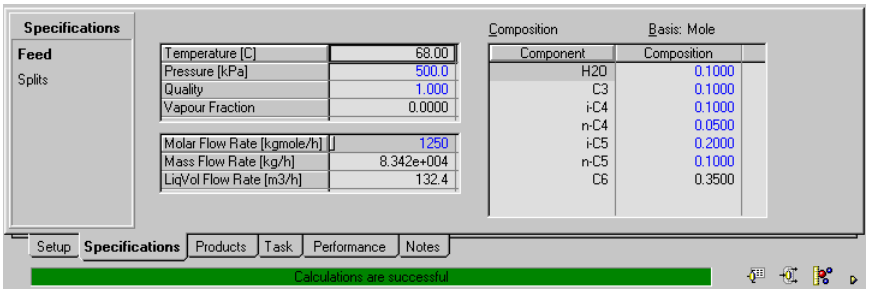
5.4.3 Specifications Tab

The Specifications tab is divided into two pages: Feed and Splits.

Feed Page

The Feed page allows you to manipulate the feed stream.

Figure 5.10



The following table lists and describes the objects available in the Feed page:

Object	Description
Temperature cell	Allows you to specify the temperature of the feed stream.
Pressure cell	Allows you to specify the pressure of the feed stream
Quality cell	Allows you to specify the quality of the feed stream. The default value is 1.
Vapour Fraction cell	Displays the vapour fraction of the feed stream. The feed stream will always be in pure liquid phase, so the vapour fraction value is always 0.
Molar Flowrate cell	Allows you to specify the flowrate of the feed stream. The default value is 1000 kgmole/h.
Mass Flow Rate cell	Displays the feed stream flow rate in terms of mass.
LiqVol Flow Rate cell	Displays the feed stream flow rate in terms of liquid volume.
Composition table	Displays all the components available in the feed stream. You can specify the composition of the feed stream by entering the fraction value in the appropriate cells.

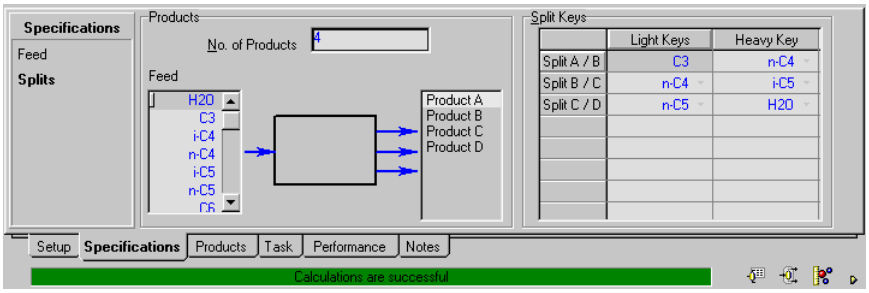
You can specify either the temperature or pressure of the feed stream, but not both.

You can specify the flow rate in mole basis only, but DISTIL can display the flow rate in a different basis.

Splits Page

The Splits page allows you to specify the number of product streams and the key components in the light and heavy splits.

Figure 5.11



The following table lists and describes the objects available in the Splits page:

Object	Description
No. of Products field	Allows you to specify the number of product streams in the column sequence design.
Feed list	Displays all the components available in the feed stream.
Product list	Displays the name of each product stream. DISTIL automatically names each product stream with the following *Product n*, where the *n* represents a letter of the alphabet, starting at *A*.
Split Keys table	Displays the splits for the pairs of product streams and allows you to specify the split for each product streams.
Light Keys column	Allows you to select the “light key” component for the first product stream in the split pair. The selected component will be the second last heaviest component allowed in the product stream. To select a component, click the down arrow in the cell to open the drop-down list.
Heavy Key column	Allows you to select the “heavy key” component for the second product stream in the split pair. To select a component, click the down arrow in the cell to open the drop-down list.

The number of product streams in the Product list depends on the number of product streams you specified in the No. of Products field.

5.4.4 Products Tab

The Products tab is divided into two pages: Recovery Matrix and Mass Balance.

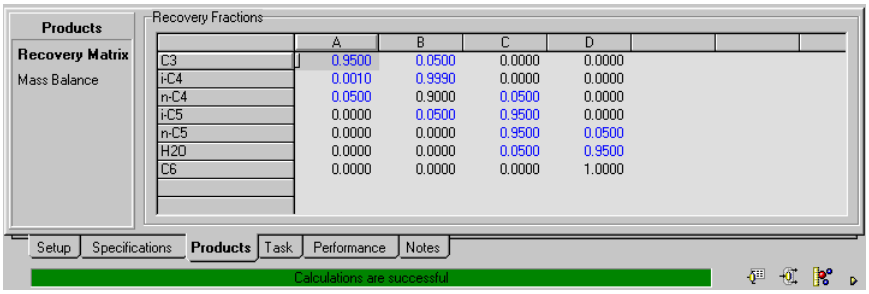
Recovery Matrix Page

Refer to the **Recovery Matrix View** section in **Section 5.4 - Scenario Level** for more information.

The blue text in the Recovery Fractions table indicates that you can change the value.

The Recovery Matrix page contains the Recovery Matrix, which displays how the fraction of the components are split into each product stream.

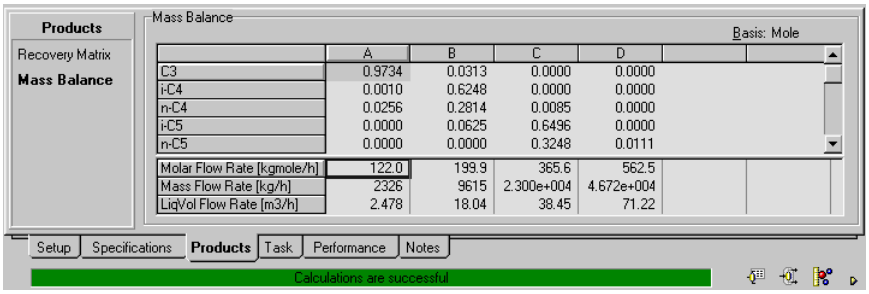
Figure 5.12



Mass Balance Page

The Mass Balance page displays the mass flow rate of the components in each product stream in a table format.

Figure 5.13



5.4.5 Task Tab

The number of tasks/splits in a column sequence depends on how many product streams are specified.

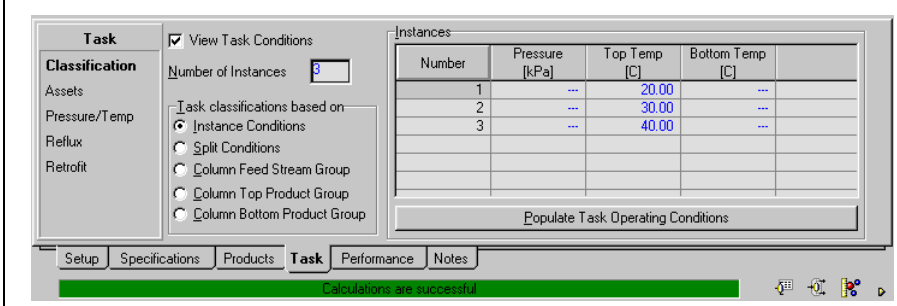
The Task tab allows you to modify/limit the configuration of the columns in the generated column sequences. Each condition/limitation is referred to as an instance. An instance is implemented/defined at the separation of one component/product from the stream mixture. The separation of one component/product from a stream mixture is referred to as a task or split.

The Task tab is divided into five pages: Classification, Assets, Pressure/Temp, Reflux, and Retrofit.

Classification Page

The Classification page allows you to specify the number and types of instances/limitations you want to use within the calculations used to generate the column sequence designs.

Figure 5.14



The following table lists and describes all the objects available in the Classification page:

Object	Description
View Task Conditions checkbox	Allows you to toggle between displaying or hiding task conditions in the *P*ressure/Temp, Reflux, and Retrofit pages.
Number of Instances field	Allows you to specify how many limitations/conditions you want to use in the column sequence calculations. The default value is 1. An integer value is used to identify each instance, beginning at 1.
Task classifications based on group	Allows you to choose the task classification by selecting the appropriate radio button.
Instances table	Allows you to specify the pressure, top temperature, and bottom temperature for each instance. Available only when the Instance Conditions radio button is selected.
Split Group table	Allows you to specify the pressure, top temperature, and bottom temperature for each split group and instance. Available only when the Split Conditions radio button is selected.
Feed Stream Group table	Allows you to specify the pressure, top temperature, and button temperature for each feed group and instance. Available only when the Column Feed Stream Group radio button is selected.
Top Product Group table	Allows you to specify the pressure and top temperature for each top product stream and instance. Available only when the Column Top Product Group radio button is selected.
Bottom Product Group table	Allows you to specify the pressure and bottom temperature for each bottom product stream and instance. Available only when the Column Bottom Product Group radio button is selected.
Populate Task Operating Conditions button	Allows you to include the specified tasks/conditions from the current table in all the possible splits of the column design calculations.

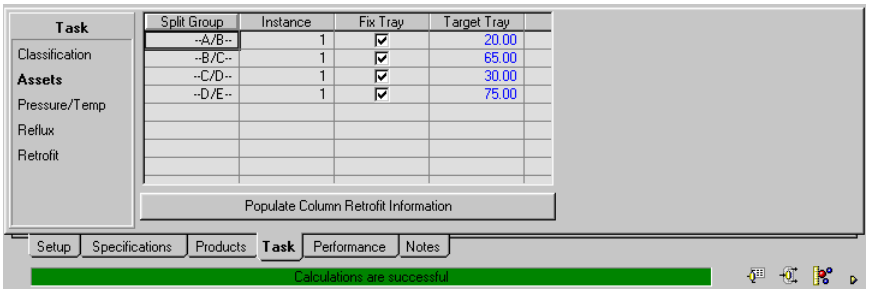
The variables in the table vary depending on which task classification radio button was selected.

The number of instances in the table depends on the value entered in the Number of Instances field.

Assets Page

The Assets page allows you to limit the number of trays within the columns in the generated column sequence designs.

Figure 5.15



The following table lists and describes the objects available in the Assets page:

Object	Description
Split Group column	Displays all the split product pairs.
Instance column	Displays the identification number of the instance that will be applied to the split product pairs.
Fix Tray column	Allows you to toggle between fixing or not fixing the number of trays for the associated split product pair.
Target Tray column	Allows you to specify the number of trays target value for the associate split product pair.
Populate Column Retrofit Information button	Allows you to use the conditions from the current table in all the possible splits of the column design calculations.

Pressure/Temp Page

The Pressure/Temp page allows you to:

- Specify pressures and/or temperatures for splits.
- Confirm that the instance you specified in the **Classification** page is applied to all the possible splits.
- Check the calculated operating pressure for the specified top or bottom temperature.
  The operating pressures do not appear until you click the **Press to generate feasibility column sequences** icon.

Press to generate feasible column sequences icon

Figure 5.16

The following table lists and describes the objects available in the Pressure/Temp page:

The task name indicates which product stream is being separated from the mixture (e.g., *B/CD* means product B is being separated from the mixture containing B, C, and D).

Object	Icon	Description
Task Name row		Displays the name of the task.
Instance row		Displays the identification number of the instance.
Accept task row	✓ ✗	Allows you to toggle between accepting or rejecting the specified instance for the column sequence calculations. • The green checkmark indicates acceptance. • The red X indicates rejection.
Pressure row		Allows you to specify the pressure for the associated task.
Top Temp row		Allows you to specify the top temperature for the associated task.
Bottom Temp row		Allows you to specify the bottom temperature for the associated task.
Op. Pressure row		Displays the calculated operating pressure for the associated task.

Object	Icon	Description
Calculation status row		Displays an icon to indicate the calculation status of the associated task. • The green icon indicates that calculation was successful. • The red icon indicates that calculation has not been performed or was not successful.
Accept All Task icon		Allows you to accept/apply all instances on all the tasks listed in the table.
Reject All Task icon		Allows you to reject/remove all instances on all the tasks listed in the table.
Invert Selection icon		Allows you to invert the accept/reject status of all instances on all the tasks listed in the table.

Reflux Page

The Reflux page shows how each specified instance/condition and minimum reflux ratio affect the configuration of the trays in each task.

Figure 5.17

The following table lists and describes the objects available in the Pressure/Temp page:

The task name indicates which product stream is being separated from the mixture (e.g., *B/CD* means product B is being separated from the mixture containing B, C, and D).

Object	Icon	Description
Task Name row		Displays the name of the task.
Instance row		Displays the identification number of the instance.
Accept task row		Allows you to toggle between accepting or rejecting the specified instance for the column sequence calculations. • The green checkmark indicates acceptance. • The red X indicates rejection.
Actual Trays row		Displays the calculated number of trays.

Object	Icon	Description
Minimum Trays row		Displays the minimum number of trays required, based on the minimum reflux ratio.
Diameter row		Displays the calculated diameter of the trays.
R/Rmin row		Allows you to change the minimum reflux ratio for the associated task.
Calculation status row		Displays an icon to indicate the calculation status of the associated task. • The green icon indicates that calculation was successful. • The red icon indicates that calculation has not been performed or was not successful.
Accept All Task icon		Allows you to accept/apply all instances on all the tasks listed in the table.
Reject All Task icon		Allows you to reject/remove all instances on all the tasks listed in the table.
Invert Selection icon		Allows you to invert the accept/reject status of all instances on all the tasks listed in the table.

Retrofit Page

The Retrofit page displays how each specified instance/condition and retrofit setting affect the reflux of each task.

Figure 5.18

The following table lists and describes the objects available in the Retrofit page:

The task name indicates which product stream is being separated from the mixture (e.g., *B/CD* means product B is being separated from the mixture containing B, C, and D).

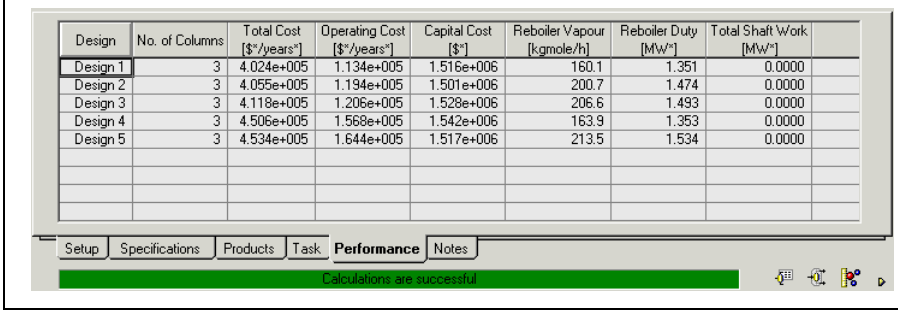
Object	Icon	Description
Task Name row		Displays the name of the task.
Instance row		Displays the identification number of the instance.

Object	Icon	Description
Accept task row		Allows you to toggle between accepting or rejecting the specified instance (on the associated task) into the column sequence calculations. • The green checkmark indicates acceptance. • The red X indicates rejection.
Adjust Trays row		Allows you to toggle between adjusting or not adjusting the trays according to the specified number of trays. • Check the checkbox to adjust the trays. • Uncheck the checkbox to leave the trays as they are.
Target Trays row		Allows you to specify the number of target trays.
Minimum Trays row		Displays the calculated minimum number of trays.
R By Rmin row		Displays the reflux ratio for the associated task and instance.
Calculation status row		Displays an icon to indicate the calculation status of the associated task. • The green icon indicates that calculation was successful. • The red icon indicates that calculation has not been performed or was not successful.
Accept All Task icon		Allows you to accept/apply all instances on all the tasks listed in the table.
Reject All Task icon		Allows you to reject/remove all instances on all the tasks listed in the table.
Invert Selection icon		Allows you to invert the accept/reject status of all instances on all the tasks listed in the table.

5.4.6 Performance Tab

The Performance tab displays the summary information on each column sequence design generated by DISTIL.

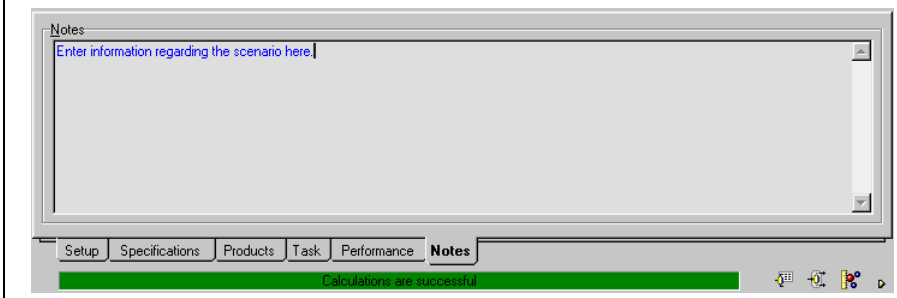
Figure 5.19



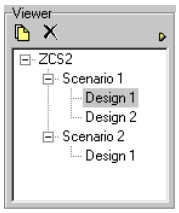
5.4.7 Notes Tab

The Notes tab allows you to enter information about the selected scenario in the Notes text editor.

Figure 5.20



5.5 Design Level



Viewer group

At Design level:

- One of the **Design** names must be selected in the Viewer group, as shown in the figure on the left.
- The Main (upper) pane displays the process flow diagram (PFD) of the column sequence in the selected design.
- The Worksheet (lower) pane contains several tabs that display the information about the streams and columns in the process flow diagram.

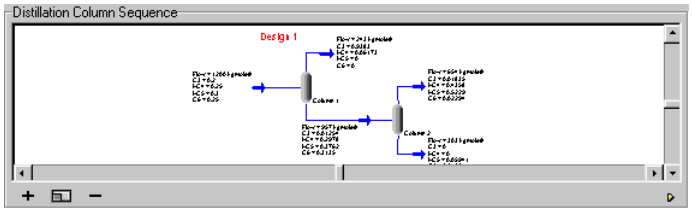
The **Open Page Tab in Separate Window** icon icons is available at the bottom of the view for all tabs:

The following sections describe the Main pane and each tab in the Worksheet pane for the Design level in more detail.

5.5.1 Main Pane

The Main pane displays the PFD of the selected design, the flow rate, and the composition of each stream in the PFD.

Figure 5.21



The following table lists and describes the objects available in the Main pane:

You can double-click on any object in the PFD, except for the streams, to open a property view of the selected object.

For more information refer to the **PFD Object View** section.

Object	Icon	Description
Process Flow Diagram		Displays the objects that make up the separation sequence.
Zoom In icon	+	Increases the relative size of the diagram so you can view the details.

Object	Icon	Description
Reset Flowsheet Size icon		Allows you to reset the focus on the PFD to the DISTIL default setting.
Zoom Out icon		Decreases the relative size of the diagram to give you an overview of the flow.
Open Design as Separate Window icon		Allows you to open the Main pane as a separate view.

PFD Object View

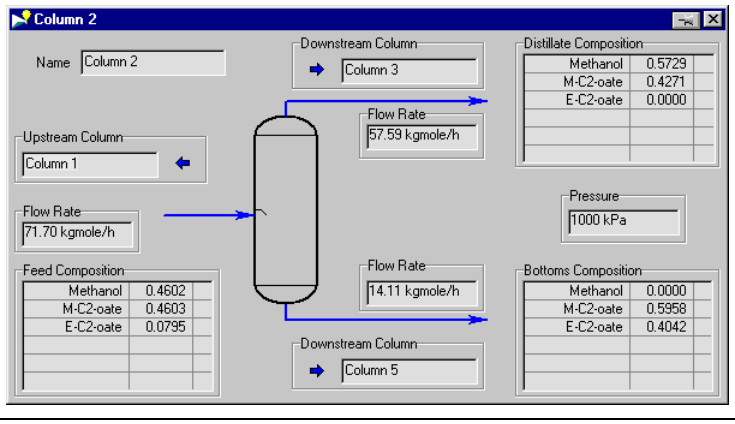
Each Process Flow Diagram object in the Main pane, except for the streams, has its own property view. The property view contains information about the pressure within the object and the flow rate and composition of the streams flowing into and out of the object.

To access the object's property view, double-click the object in the PFD.

Column Sequencing operation contains the following PFD objects:

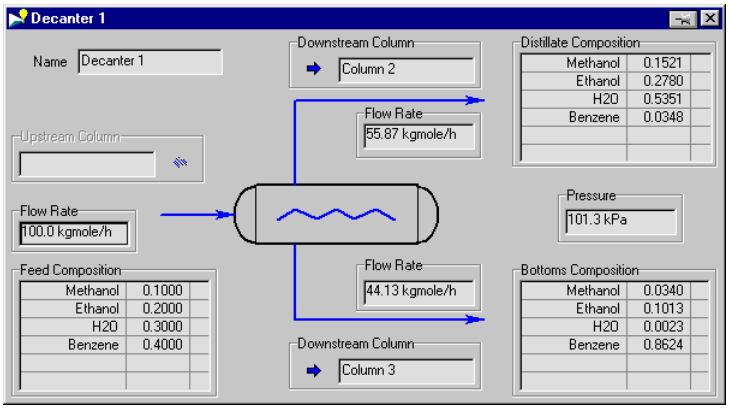
- Column

Figure 5.22



- Decanter

Figure 5.23



You can view the previous or next object in the sequence by doing one of the following:

- On the **Main** pane of the Column Sequencing view, double-click the previous or next object in the sequence.
- In the current object property view, click the Right-arrow icon in the **Downstream Column** group to open the downstream object view.
- In the current object property view, click the Left-arrow icon in the **Upstream Column** group to open the upstream object view.

Right-arrow icon

Left-arrow icon

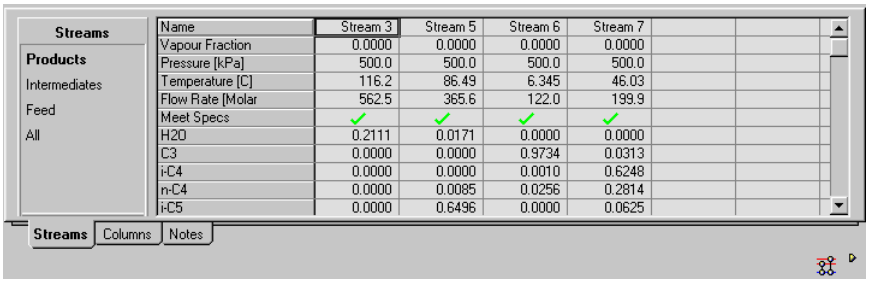
5.5.2 Streams Tab

The Streams tab contains information about all the streams in the column sequence design. The information of the streams is divided into four pages: Products, Intermediates, Feed, and All.

Products Page

This page displays information about all the product streams.

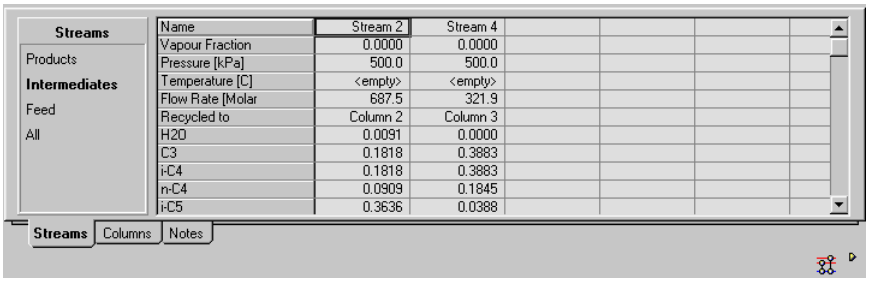
Figure 5.24



Intermediates Page

This page displays information about all the streams internal to the flowsheet.

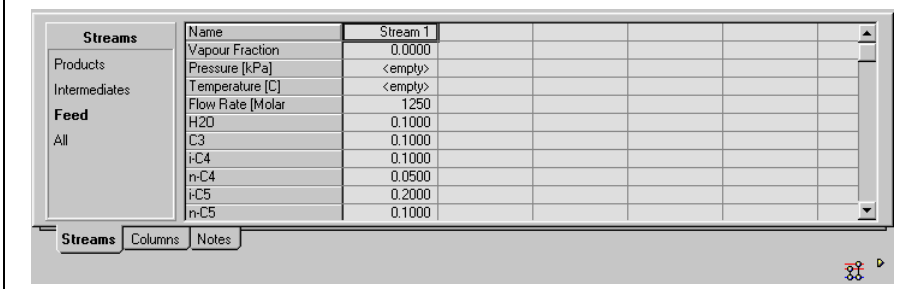
Figure 5.25



Feed Page

This page displays information about the feed stream.

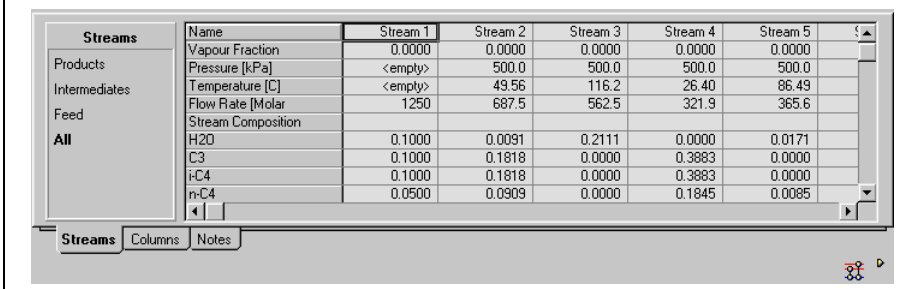
Figure 5.26



All Page

This page displays information about all the streams in the column sequence.

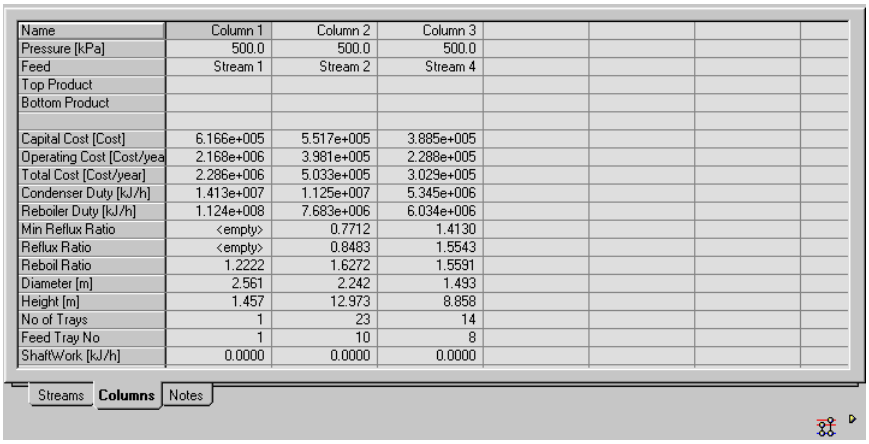
Figure 5.27



5.5.3 Columns Tab

The Columns tab displays information about all the columns in the column sequence.

Figure 5.28



Name	Column 1	Column 2	Column 3
Pressure [kPa]	500.0	500.0	500.0
Feed	Stream 1	Stream 2	Stream 4
Top Product			
Bottom Product			
Capital Cost [Cost]	6.166e+005	5.517e+005	3.885e+005
Operating Cost [Cost/yea	2.168e+006	3.981e+005	2.288e+005
Total Cost [Cost/year]	2.286e+006	5.033e+005	3.029e+005
Condenser Duty [kJ/h]	1.413e+007	1.125e+007	5.345e+006
Reboiler Duty [kJ/h]	1.124e+008	7.683e+006	6.034e+006
Min Reflux Ratio	<empty>	0.7712	1.4130
Reflux Ratio	<empty>	0.8483	1.5543
Reboil Ratio	1.2222	1.6272	1.5591
Diameter [m]	2.561	2.242	1.493
Height [m]	1.457	12.973	8.858
No of Trays	1	23	14
Feed Tray No	1	10	8
ShaftWork [kJ/h]	0.0000	0.0000	0.0000

5.5.4 Notes Tab

The Notes tab allows you to enter information about the selected column sequence design in the Design Notes text editor.

Figure 5.29

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