Unit Operations in Aspen HYSYS

Part 7

Oil Characterization and Atmospheric Distillation in Aspen HYSYS

Ref:
Hysys Tutorials

Oil Characterization

- The petroleum characterization method in HYSYS will convert laboratory analyses of condensates, crude oils, petroleum cuts and coal-tar liquids into a series of discrete hypothetical components.
- These petroleum pseudo components provide the basis for the property package to predict the remaining thermodynamic and transport properties necessary for fluid modeling.

Oil Characterization

- The minimum amount of information that HYSYS requires to characterize an oil:
  - A laboratory distillation curve

  Or

  - Two of the following bulk properties: MW, Density, or Watson K factor

Oil Characterization

- There are three steps involved in characterizing any oil in HYSYS:
  1. Characterize the Assay
  2. Generate Pseudo Components
  3. Install the Oil in the Flowsheet

Oil Characterization

- **Characterize the Assay**

The assay contains all of the petroleum laboratory data, boiling point curves, light ends, property curves and bulk properties. HYSYS uses the supplied Assay data to generate internal TBP, molecular weight, density and viscosity curves, referred to as Working Curves.

Oil Characterization

- **Characterize the Assay - Assay Types**

Accurate volatility characteristics are vital when representing a petroleum fluid in your process simulation. These may include light ends data, distillation data, molecular weight, viscosity, and density curves. HYSYS accepts the following standard laboratory analytical assay procedures: True Boiling Point (TBP), ASTM D86, D1160 distillation, D86_D1160, ASTM D2887, Equilibrium Flash Vaporization (EFV) and Chromatographic Analysis.

Oil Characterization

- **Characterize the Assay- Light Ends**

Light Ends are defined as pure components with low boiling points. Components in the boiling range of C2 to n-C5 are most commonly of interest. HYSYS provides three options to account for Light Ends:

- Ignore - HYSYS will characterize the Light Ends portion of your sample as pseudo components. This is the least accurate method and as such, is not recommended.
- Auto Calculate - Select this when you do not have a separate Light Ends analysis but you want the low boiling portion of your assay represented by pure components. HYSYS will only use the pure components you have selected in the Fluid Package.

Oil Characterization

- **Characterize the Assay - Light Ends**

  • Input Composition - Select this when you have a separate Light Ends assay and your petroleum assay was prepared with the Light Ends in the sample. HYSYS will provide a form listing the pure components you selected in the Fluid Package. This is the most accurate method of representation.

Oil Characterization

- **Characterize the Assay - Bulk Properties**

Bulk Properties for the sample may also be supplied. The bulk properties are optional if a distillation curve or chromatograph have been supplied.

- Molecular Weight - This is the Molecular Weight of the bulk sample. It must be greater than 16.
- Mass Density - The mass density must be between 250 and 2000 kg/m3 (15.6 and 125 lb/ft3).
- Watson (UOP) K Factor - This must be between 8 and 15.
- Bulk Viscosity's - Given at two reference temperatures, typically 37.78 C and 98.89 C (100 F and 210 F).

Oil Characterization

- **Characterize the Assay - Physical Property Curves**

HYSYS accepts different types of physical property curves

- Molecular Weight Curve
- Density Curve
- Viscosity Curve

Oil Characterization

- **Characterize the Assay - Physical Property Curves**

Physical property analyses are normally reported from the laboratory using one of the following two conventions.

- An Independent assay basis, where a common set of assay fractions is NOT used for both the distillation curve and the physical property curve
- A Dependent assay basis, where a common set of assay fractions is utilized for both the distillation curve and the physical property curve.

Oil Characterization

- **Characterize the Assay**

As you supply more information to HYSYS, the accuracy of the Petroleum Characterization increases.

Case Study 1

- Adding Assay Data

TBP curve

Assay %	Temperature °C (°F)
0	-10°C (15°F)
4	32°C (90°F)
9	74°C (165°F)
14	116°C (240°F)
20	154°C (310°F)
30	224°C (435°F)
40	273°C (524°F)
50	327°C (620°F)
60	393°C (740°F)
70	474°C (885°F)
76	521°C (969°F)
80	546°C (1015°F)
85	566°C (1050°F)

Case Study 1

- Adding Assay Data

Light Ends	Compositions
Input Data	
Methane	0.0065
Ethane	0.0225
Propane	0.3200
i-Butane	0.2400
H_2O	0.0000

Case Study 1

- Adding Assay Data

Select the Bulk radio button to enter the Bulk information.

Enter an API Gravity of 29.32°API_60 for the crude.

Once you have entered all of the data, press the Calculate button.

As the Assay is calculated, the working curves are displayed on the Working Curves tab. The working curves are regressed from the Assay input. The calculation of the Blend is based on these working curves.

Case Study 1

- **Pseudo Component Generation/Blending the Oil**

The Cut/Blend characterization in HYSYS splits the internal working curves for one or more assays into pseudo components. The Blend tab of the Oil Characterization view provides two functions, Cutting the Oil into Pseudo Components and Blending two or more Assays into one set of pseudo components.

The results of the calculation can be viewed on the Tables tab of the Blend view.

Case Study 1

- **Installing the Oil in the Flowsheet**

The final step of the characterization is to transfer the pseudo component information into the Flowsheet.

Add Stream ‘Raw Crude’ .

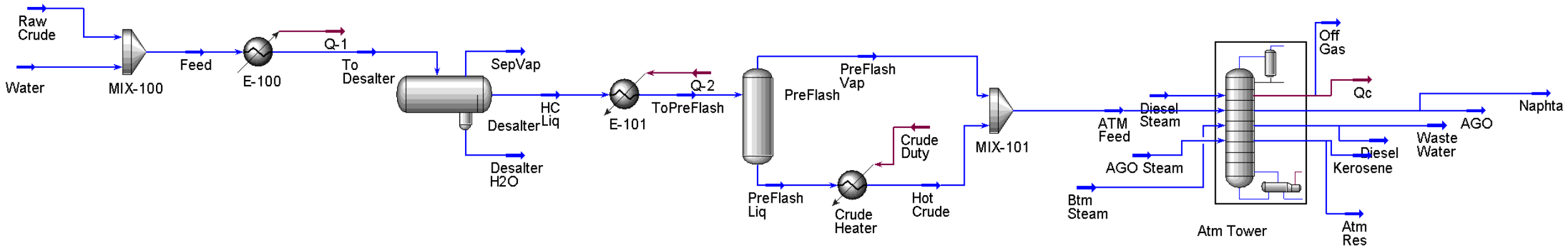
Case Study 1

- **Building the Simulation**
  - Atmospheric Crude Columns are one of the most important pieces of equipment in the petroleum refining industry. Typically located after the Desalter and the Crude Furnace, the Atmospheric Tower serves to distil the crude oil into several different cuts. These include naphtha, kerosene, light diesel, heavy diesel and AGO.
  - Before beginning the construction of a crude column it is useful to know the quantity of products that you can expect to get out of the column (use Distribution Plot).

Case Study 1 – Atmospheric Distillation

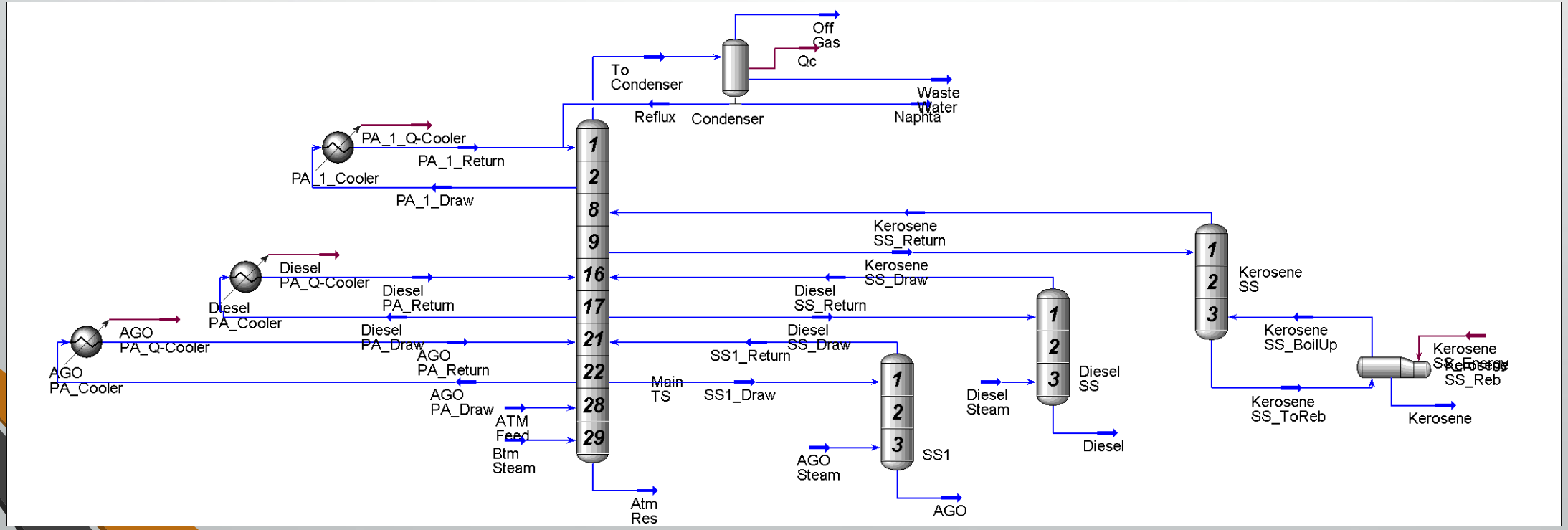
Desalter and the Crude Furnace

Atmospheric Distillation Tower



Case Study 1 – Atmospheric Distillation

Atmospheric Distillation Tower Sub-flowsheet



Case Study 1

- **Building the Simulation**
  - Complete table

Component	Volume %	Volume in 100,000 bbl.
Off Gas + Lt St Run		
Naphtha		
Kerosene		
Diesel (Light & Heavy)		
AGO		
Residue		

Case Study 1

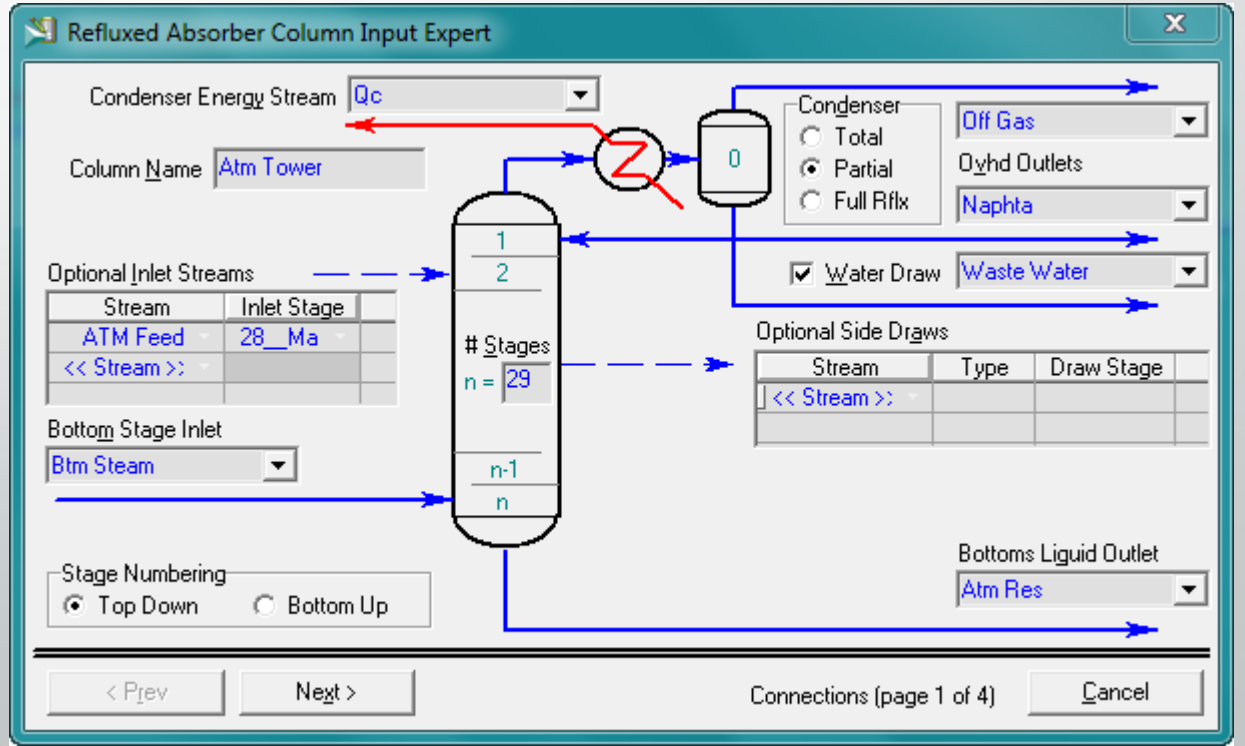
- **Building the Simulation**
  - Adding the Column Steam Feed

	Temperature	Pressure	Flowrate
Btm Steam	190°C (375°F)	1035 kPa (150 psia)	3400 kg/h (7500 lb./hr)

Case Study 1

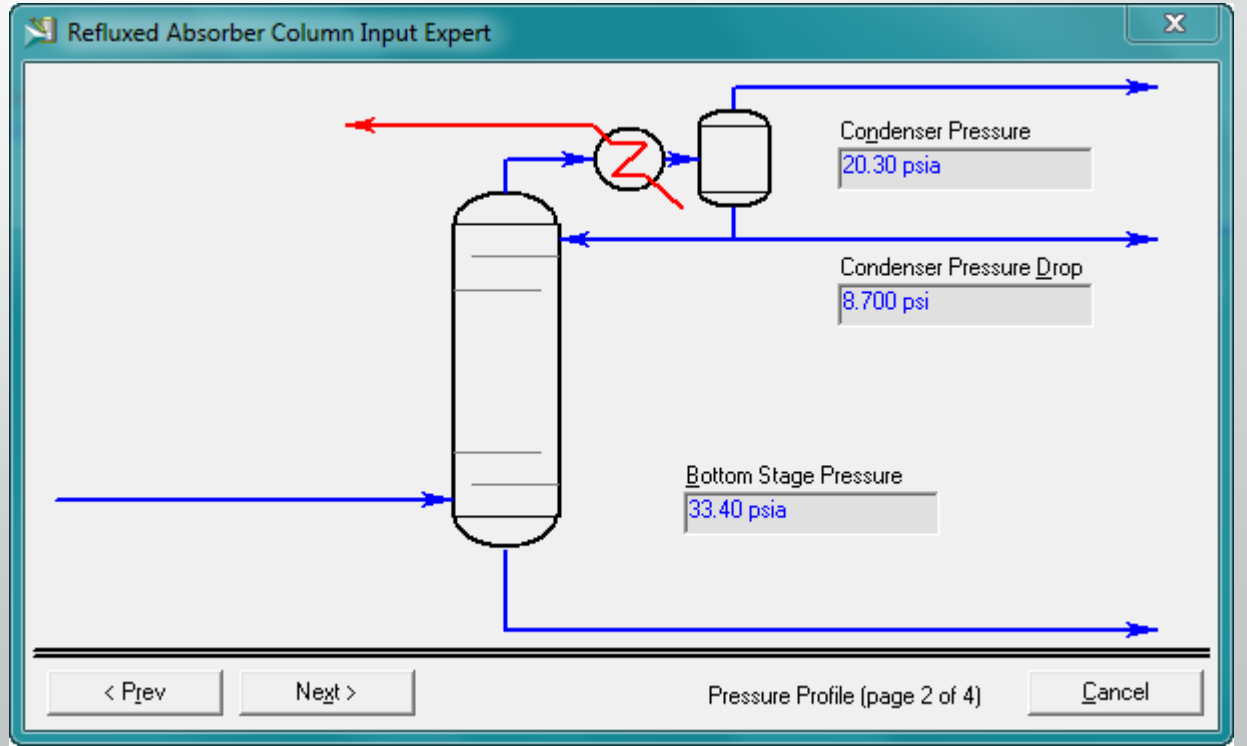
- **Building the Simulation**
  - Add the Atmospheric Crude Column

The Atmospheric Column will be simulated as a Refluxed Absorber.



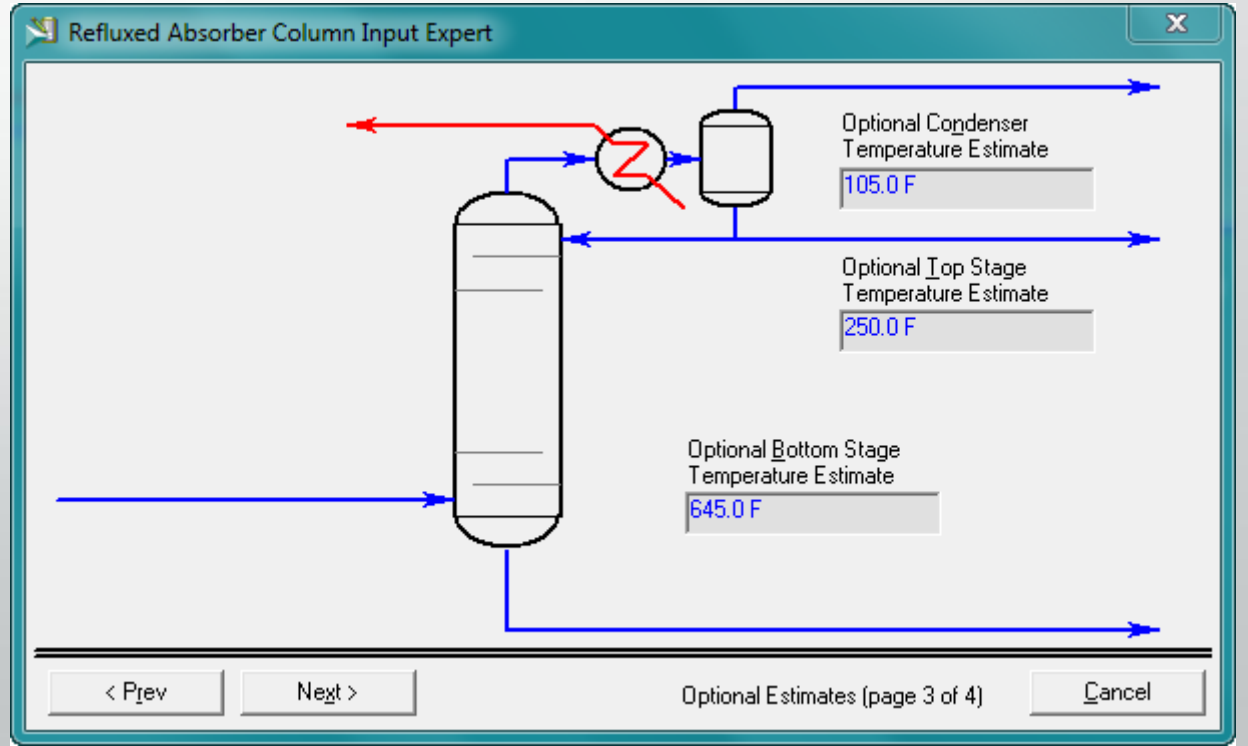
Case Study 1

- **Building the Simulation**



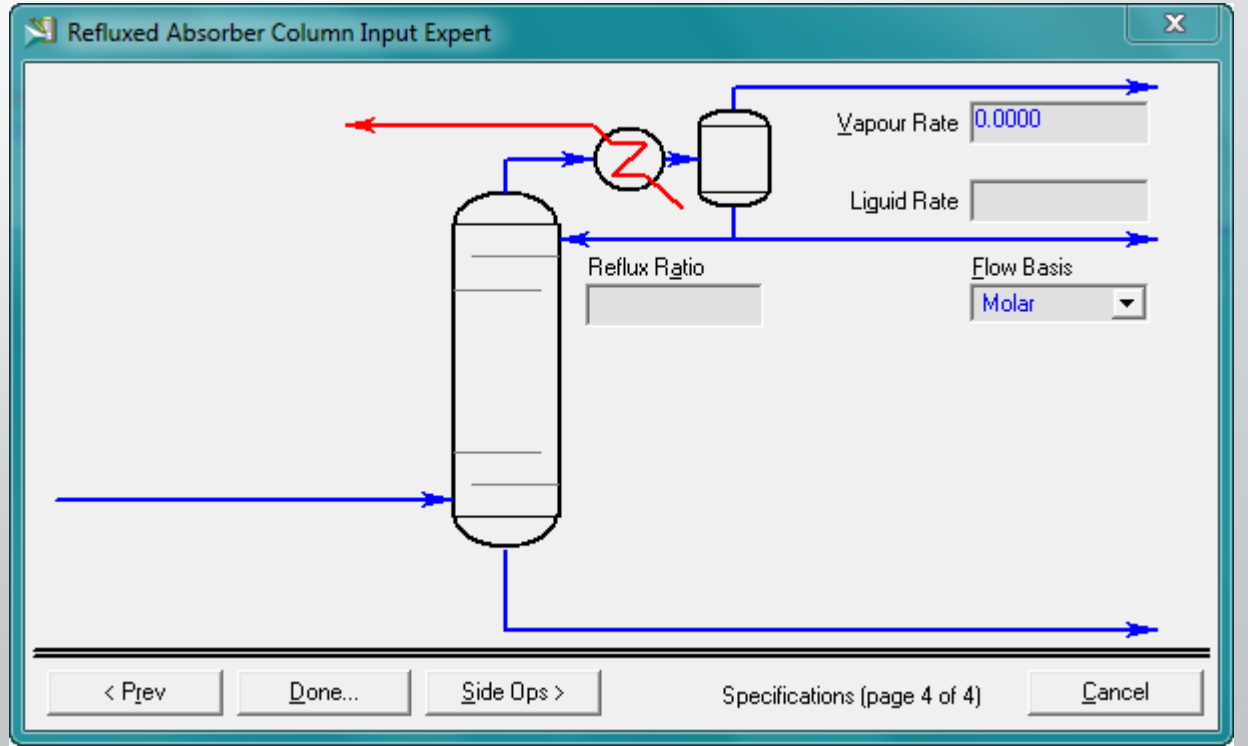
Case Study 1

- **Building the Simulation**



Case Study 1

- **Building the Simulation**



Case Study 1

- **Building the Simulation**

  Specify a distillate rate of 150 m3/hr (22,500 bbl/day). For this column to solve we need to activate the Vap Prod Rate specification with a flow rate of 0. This means that the condenser will operate as a total condenser.

  Press the Run button to converge the column.

Case Study 1

- **Building the Simulation**
  - Adding the Side Strippers and the Pump Arounds

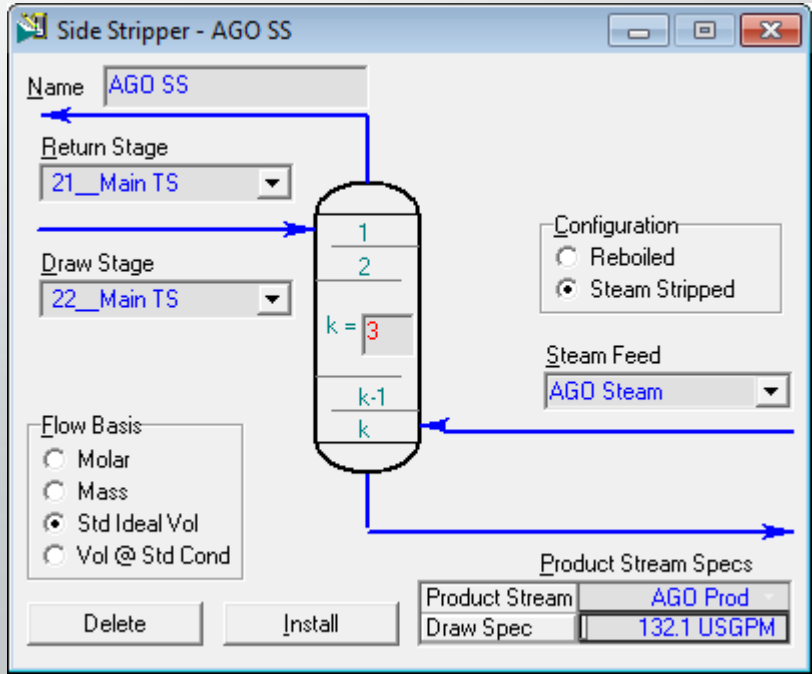
  Side Strippers are added to the column in order to improve the quality of the three main products (Kerosene, Diesel, and AGO). There are two types of side strippers available in HYSYS: Reboiled and Steam Stripped. We will install one reboiled side stripper and two steam stripped.

  Pump Arounds help to improve the column's efficiency. They operate by drawing a liquid stream from one stage cooling it, and pumping it into a higher stage. In effect, this process adds to the reflux between these two stages.

Case Study 1

- **Building the Simulation**
  - Adding the Side Strippers and the Pump Arounds

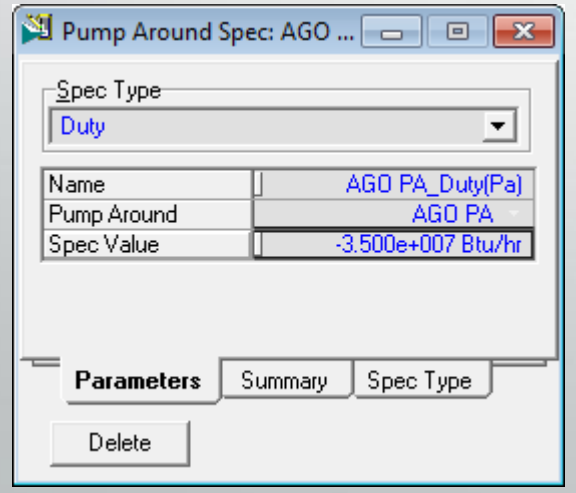
  Under the Side Ops tab, select Side Strippers; press the Add button and enter the information as shown:

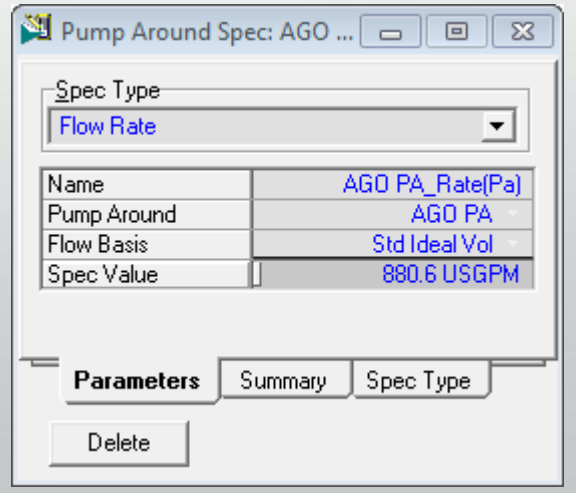


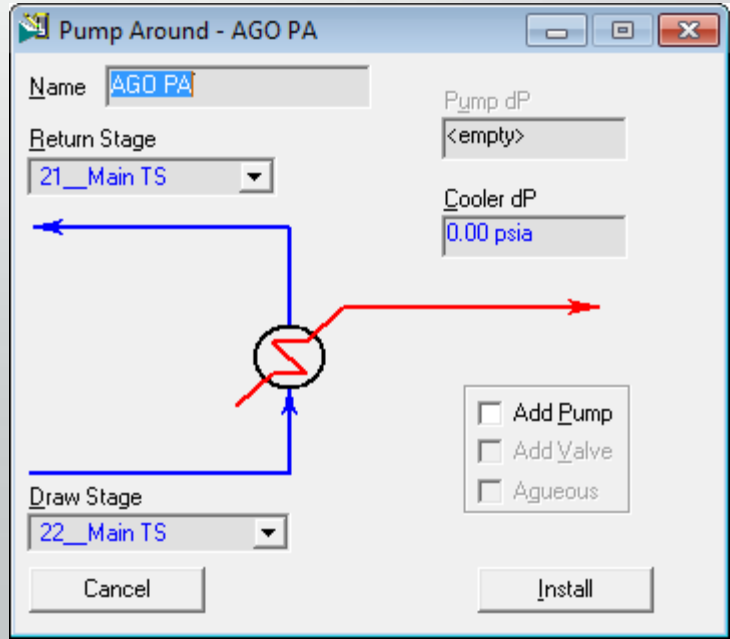
Case Study 1

- **Building the Simulation**
  - Adding the Side Strippers and the Pump Arounds

Still under the Side-Ops tab, select Pump Arounds and press the Add button. Enter the data as shown:







Case Study 1

- **Building the Simulation**

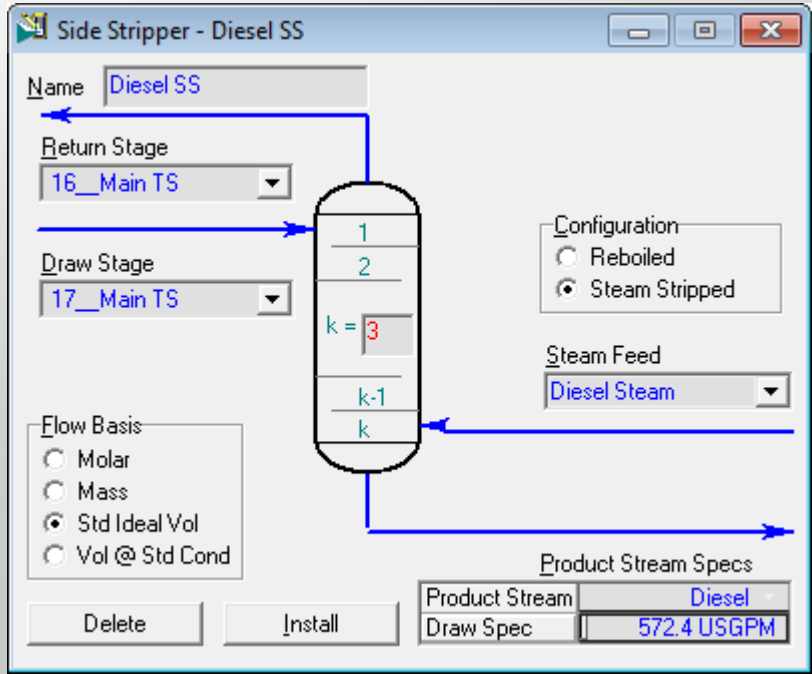
  On the Work Sheet tab, enter the following information for the AGO Steam stream:

In this Cell...	Enter...
Temperature	150 ^{o}C (300 ^{o}F)
Pressure	350 kPa (50 psia)
Mass Flow	1150 kg/hr (2500 lb/hr)

Case Study 1

- **Building the Simulation**
  - Adding the Diesel Side-Ops

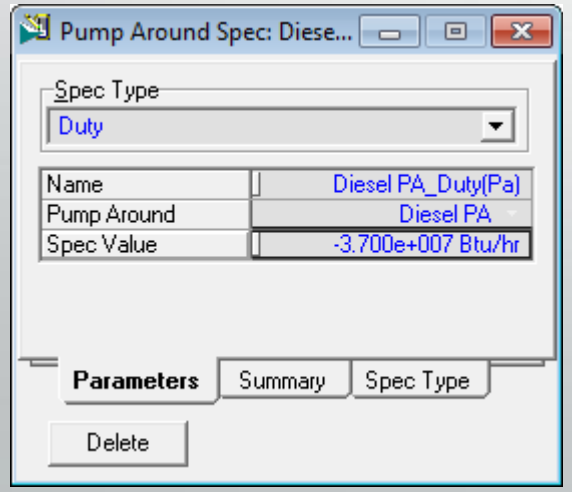
Under the Side Ops tab, select Side Strippers; press the Add button and enter the information as shown:

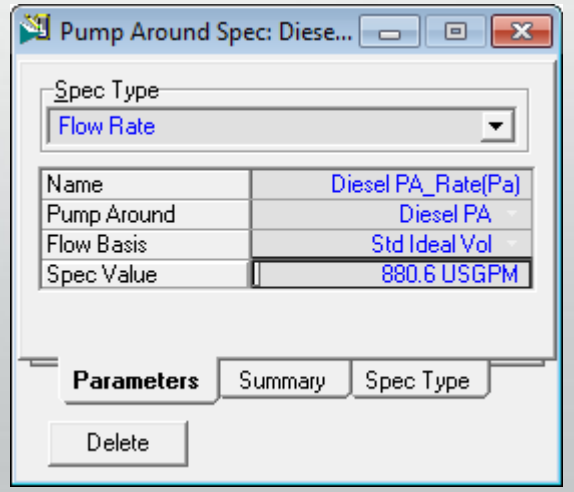


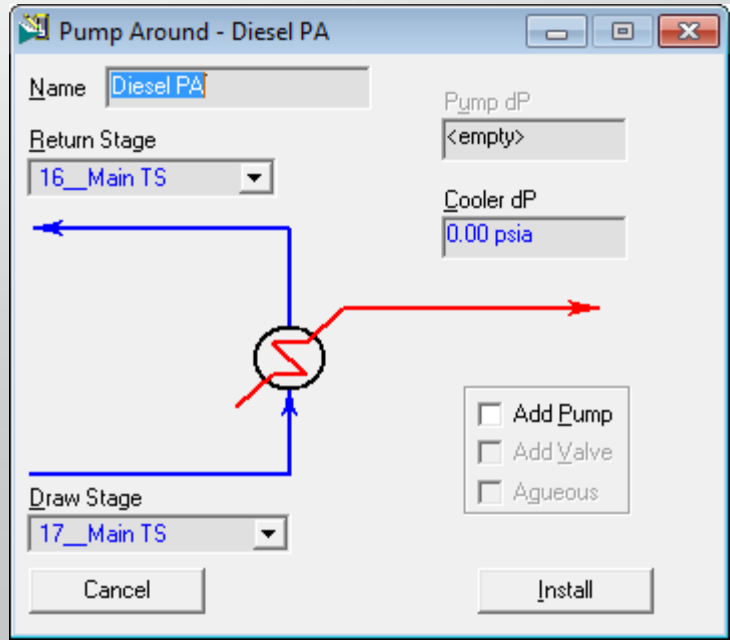
Case Study 1

- **Building the Simulation**
  - Adding the Diesel Side-Ops

Still under the Side-Ops tab, select Pump Arounds and press the Add button. Enter the data as shown:







Case Study 1

- **Building the Simulation**

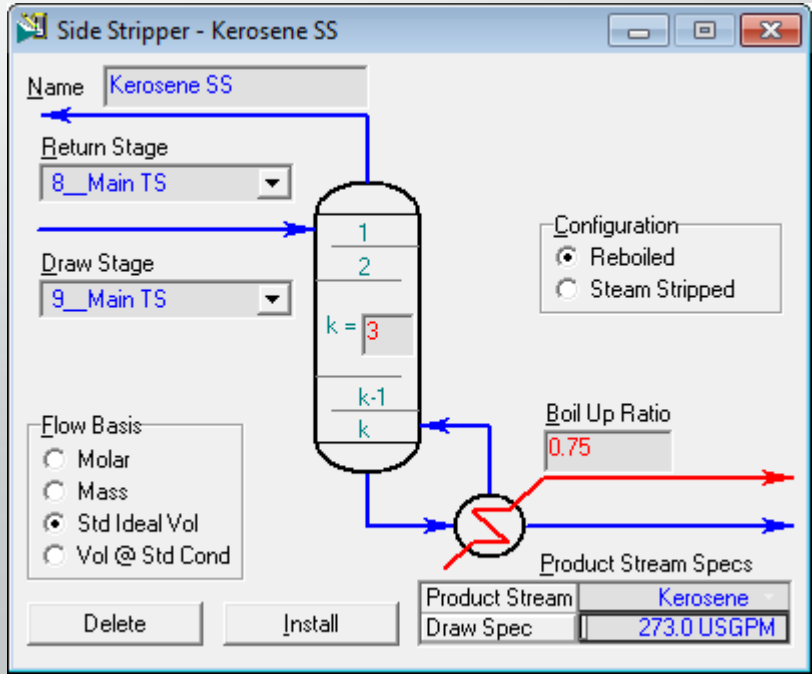
  On the Work Sheet tab, enter the following information for the Diesel Steam stream:

In this Cell...	Enter...
Temperature	150 ^{o}C (300 ^{o}F)
Pressure	350 kPa (50 psia)
Mass Flow	1350 kg/hr (3000 lb./hr)

Case Study 1

- **Building the Simulation**
  - Adding the Kerosene Side-Ops

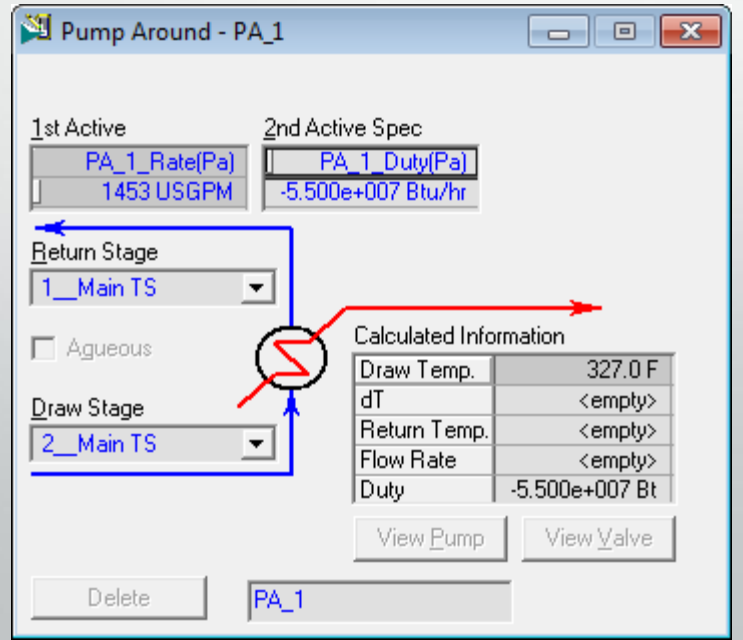
Under the Side Ops tab, select Side Strippers; press the Add button and enter the information as shown:

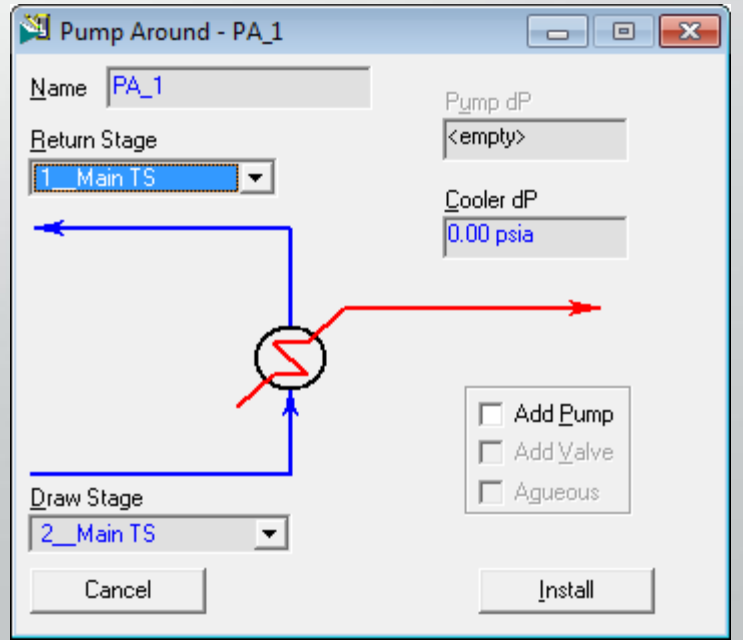


Case Study 1

- **Building the Simulation**
  - Adding the Kerosene Side-Ops

Still under the Side-Ops tab, select Pump Arounds and press the Add button. Enter the data as shown:





Finish!