

Propane Refrigeration Loop

Workshop

Refrigeration systems are commonly found in the natural gas processing industry and in processes related to the petroleum refining, petrochemical, and chemical industries. Refrigeration is used to cool gas to meet a hydrocarbon dewpoint specification and to produce a marketable liquid.

In this module you will construct, run, analyze, and manipulate a propane refrigeration loop simulation. You will convert the completed simulation to a template, making it available to connect to other simulations.

Learning Objectives

Once you have completed this module, you will be able to:

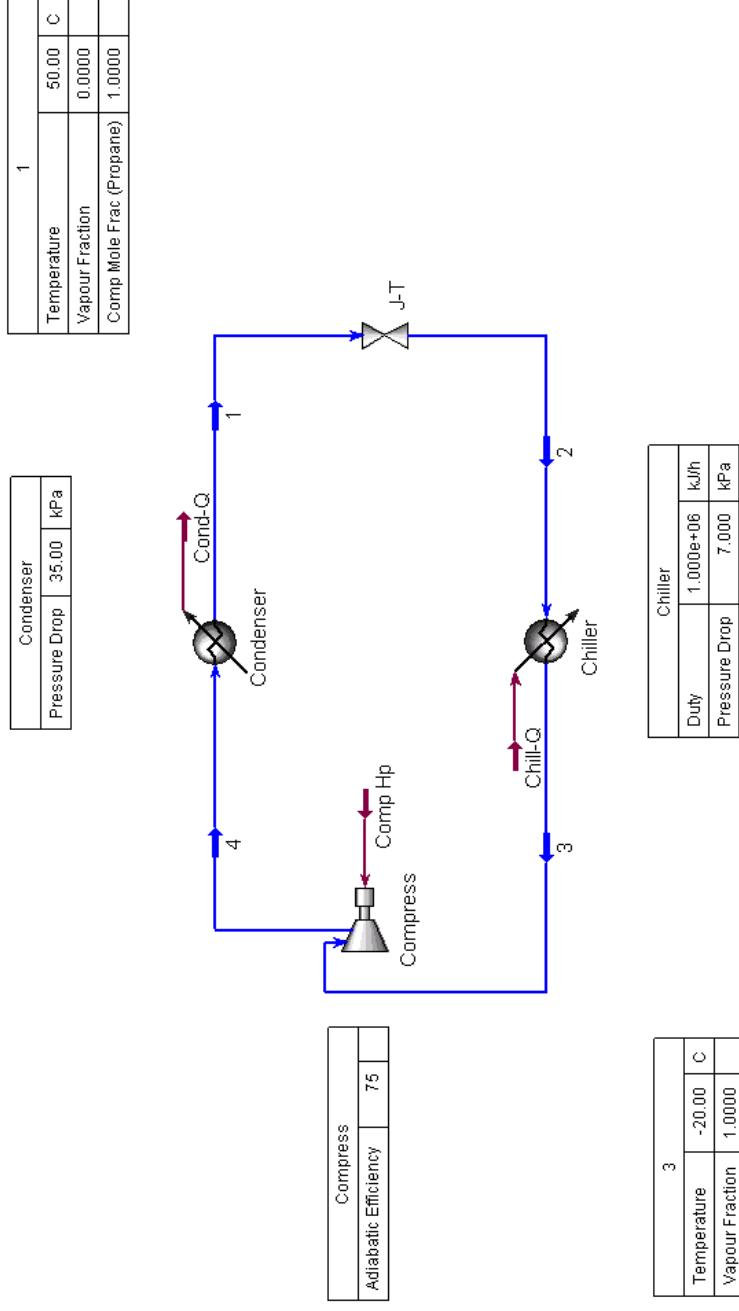
- Add and connect operations to build a flowsheet
- Use the graphical interface to manipulate flowsheets in UniSim Design
- Understand forward-backward information propagation in UniSim Design
- Convert simulation cases to templates

Prerequisites

Before beginning this module, you need to know how to:

- Define a fluid package
- Define streams
- Navigate the Workbook interface

Process Overview



Building the Simulation

The first step in building any simulation is defining the fluid package. A brief recap on how to define a fluid package and install streams is described below. [For a complete description, see the previous module].

Defining the Simulation Basis

1. Create a New Case and add a fluid package.
2. Enter the following values in the specified fluid package view:

On this page...	Select...
Property Package	Peng Robinson
Components	C3

3. Click the **Enter Simulation Environment** button when you are ready to start building the simulation.

Installing a Stream

There are several ways to create streams. (For a complete description, see the previous module.)

- Press **F11**. The Stream property view appears.

or

- Double-click the Stream icon in the Object Palette.

Defining Necessary Streams

Add a stream with the following values.

In this cell...	Enter...
Name	1
Vapour Fraction	0.0
Temperature	50°C (120°F)
Composition	C3 - 100%

Add a second stream with the following properties:

In this cell...	Enter...
Name	3
Temperature	-20°C (-4°F)
Vapour Fraction	1.0



What is the pressure of Stream 1? _____

Adding Unit Operations to a Flowsheet

As with streams, there are a variety of ways to add unit operations in UniSim Design:

To use the...	Do this...
Menu Bar	From the Flowsheet menu, select Add Operation or Press F12 . The UnitOps view appears.
Workbook	Open the Workbook and go to the UnitOps page, then click the Add UnitOp button. The UnitOps view appears.
Object Palette	From the Flowsheet menu, select Palette , or press F4 . Double-click the icon of the unit operation you want to add.
PFD/Object Palette	Using the right mouse button, drag 'n' drop the icon from the Object Palette to the PFD.

The propane refrigeration loop consists of four operations:

- Valve
- Chiller
- Compressor
- Condenser

In this exercise, you will add each operation using a different method of installation.

Adding a J-T Valve

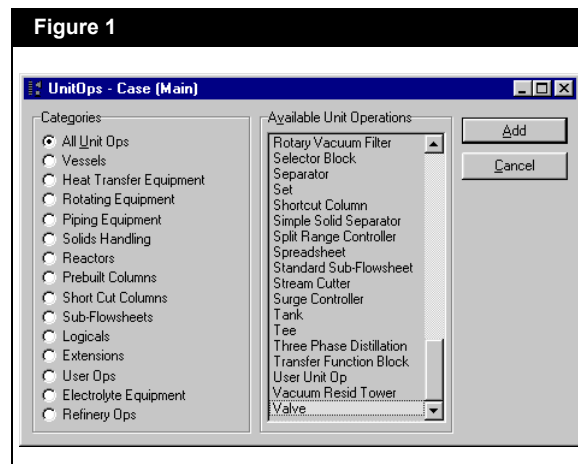
The J-T Valve is modelled using the Valve operation in UniSim Design. The inlet to the valve comes from the condenser outlet. The condenser outlet is at its bubble point.

The valve will be added using the **F12** hot key.

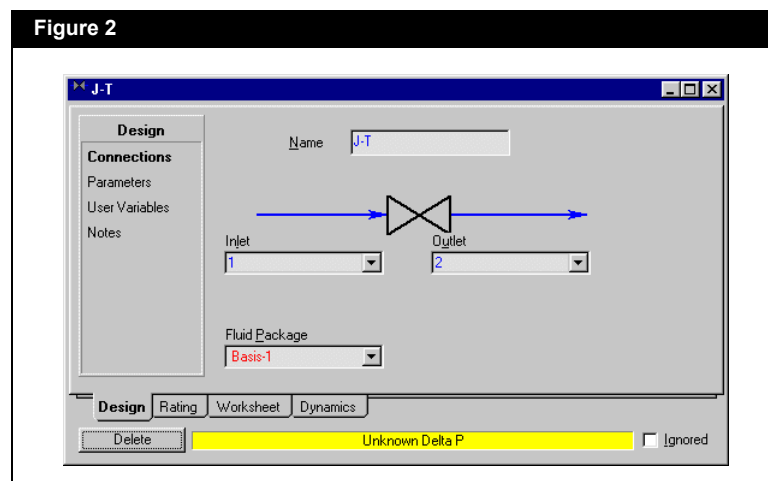


You can filter the Available Unit Operations list by selecting an appropriate Category. In this case, **Piping Equipment** would filter the list to include the Valve operation.

1. Press **F12**. The UnitOps view appears:



2. Select **Valve** from the Available Unit Operations list.
3. Click the **Add** button. The Valve property view appears.
4. On the **Connections** page, supply the inlet and outlet connections as shown below:





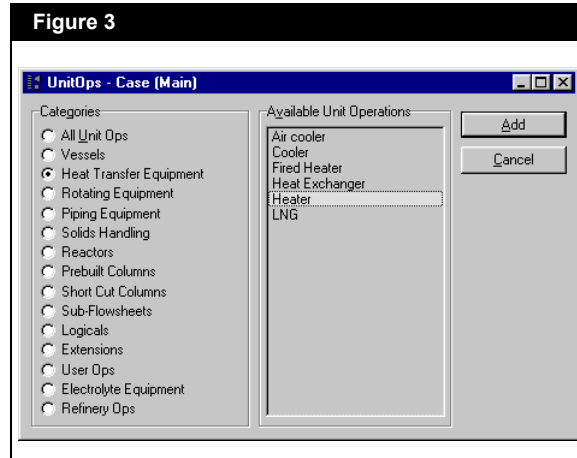
Drop-down lists, such as for the Feed and Product streams, contain lists of available streams which can be connected to the operation.

Adding a Chiller

The Chiller operation in the propane loop is modelled in UniSim Design using a Heater operation. The outlet of the Chiller will be at its dewpoint.

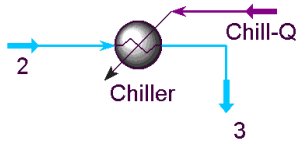
To add a heater:

1. Open the Workbook and click the **Unit Ops** tab.
2. Click the **Add UnitOp** button. The UnitOps **view appears**.
3. Select **Heat Transfer Equipment** from the Categories group.
4. Select **Heater** from the Available Unit Operations list as shown below.



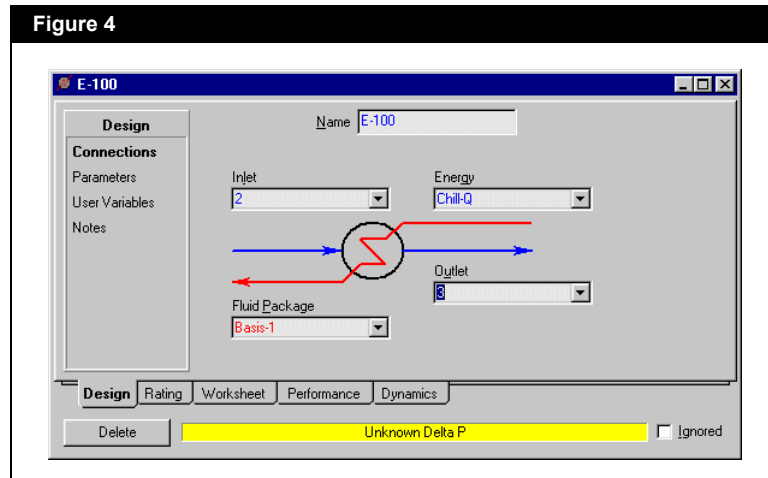
5. Click the **Add** button, or double click on Heater. The Heater property view appears.

6. On the **Connections** page, enter the information as shown below:



Chiller		
DUTY	1.000e+006	kJ/h
Pressure Drop	7.000	kPa

Figure 4



7. Go to the **Parameters** page.
 8. Enter a **Delta P** value of **7.0 kPa** (1 psi) and a Duty value of **1.00e+006 kJ/h** (1.00e+06 Btu/hr) for the Chiller.

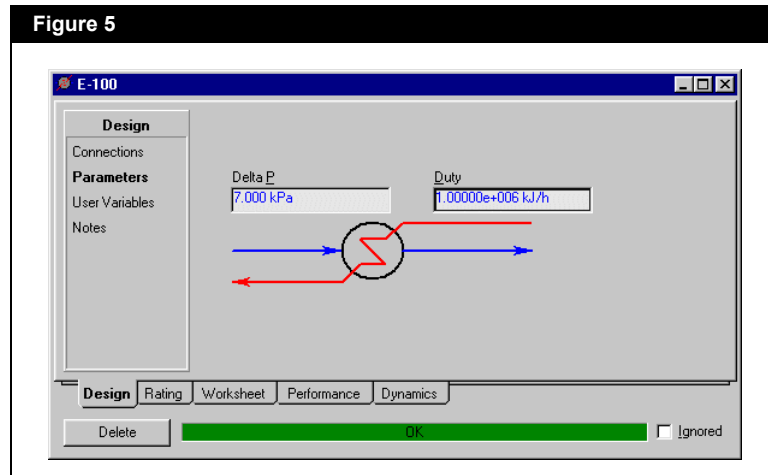


The Parameters page will be common to most unit operations and contains parameters such as Delta P, Duty, and Efficiency.



Placing the mouse arrow on a button in the Object Palette will display a fly-by description for the button.

Figure 5



9. Close the property view.



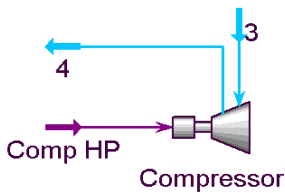
What is the molar flowrate of propane?

What is the pressure drop across the J-T valve?

What is the temperature of the valve outlet (stream 2)?



Compressor icon



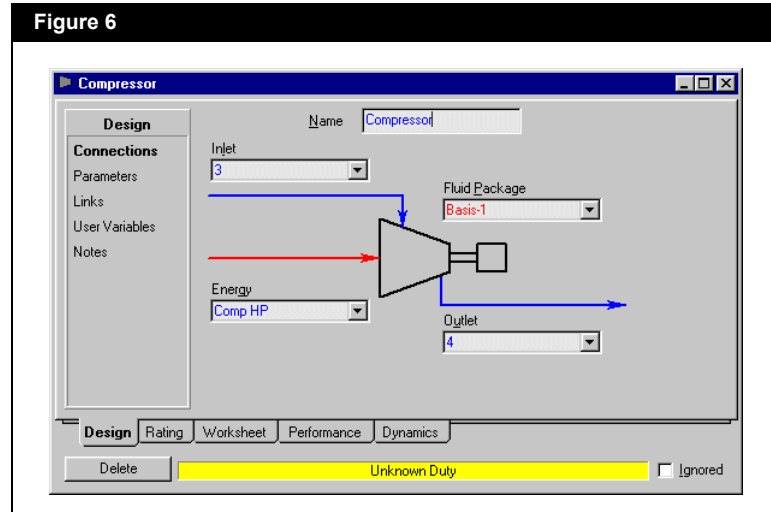
Compressor	
Adiabatic Efficiency	75

Adding a Compressor

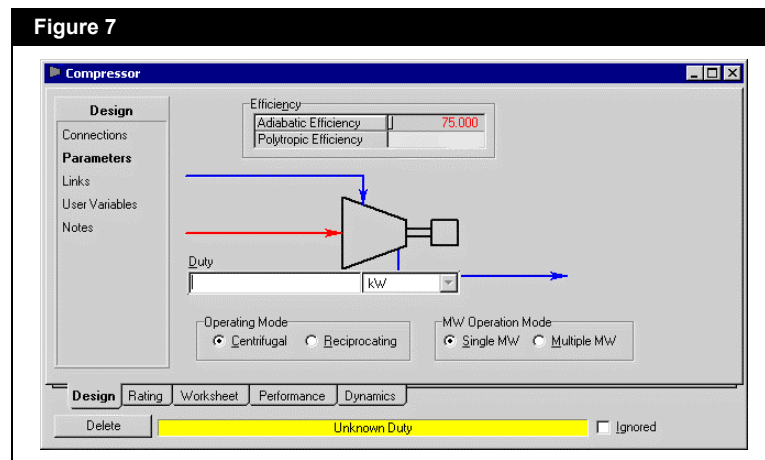
The Compressor operation is used to increase the pressure of an inlet gas stream.

To add a compressor:

1. Press **F4**. The Object Palette appears.
2. Double-click the **Compressor** icon on the Object Palette. The Compressor property view appears.
3. On the **Connections** page, enter the stream information as shown below:



4. Complete the **Parameters** page as shown:



Adding the Condenser

The Condenser operation completes the propane refrigeration loop. It is placed between the Compressor and the Valve and is modelled as a Cooler operation.

Working with a graphical representation, you can build your flowsheet in the PFD using the mouse to install and connect objects. This procedure describes how to install and connect the Cooler using the Object Palette drag 'n' drop technique.


Using Drag 'n' Drop in the PFD

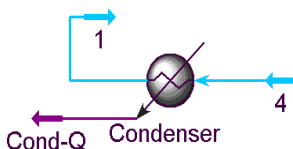


Cooler icon

1. Click the **Cooler** icon on the Object Palette.
2. Move the cursor to the PFD. The cursor will change to a special cursor, with a box and a plus (+) symbol attached to it. The box indicates the size and location of the cooler icon.
3. Click again to "drop" the cooler onto the PFD.

There are two ways to connect the operation to a stream on the PFD:

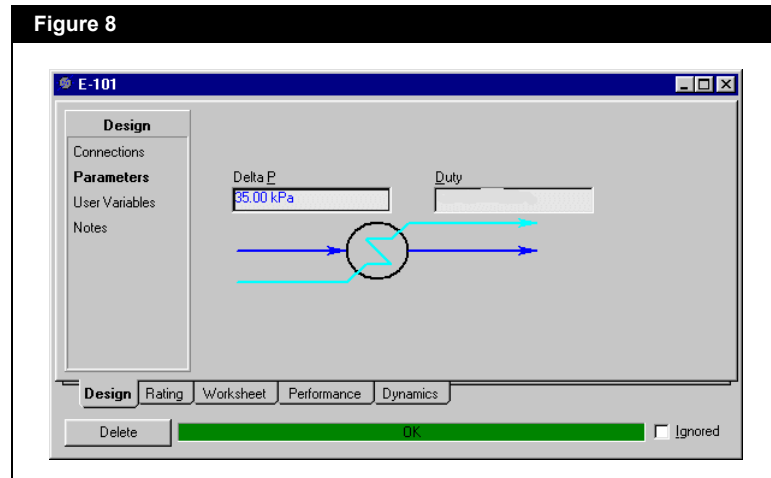
To connect using the...	Do this...
Attach Mode toggle 	<ol style="list-style-type: none"> 1. Press the Attach Mode toggle button. 2. Place the cursor over the operation. The Feed Stream connection point is highlighted in dark blue. 3. Move the cursor over the stream you want to connect. 4. Press and hold the left mouse button. 5. Move the cursor to the operation icon and release the mouse button.
CTRL key	<ol style="list-style-type: none"> 1. Press and hold the CTRL key and pass the cursor over the operation. 2. Place the cursor over the stream you want to connect. 3. Press and hold the left mouse button. 4. Move the cursor to the operation icon and release the mouse button and the CTRL key.



Condenser		
Pressure Drop	35.00	kPa

5. From the PFD, connect stream 4 to the Condenser inlet and connect the Condenser outlet to stream 1.
6. Double-click on the Condenser.

7. On the **Parameters** page, enter a Delta P of **35 kPa** (5 psi).



Hint: Clone a unit set and set the Power to "hp" units.



What is the compressor energy in hp?

Save your case!