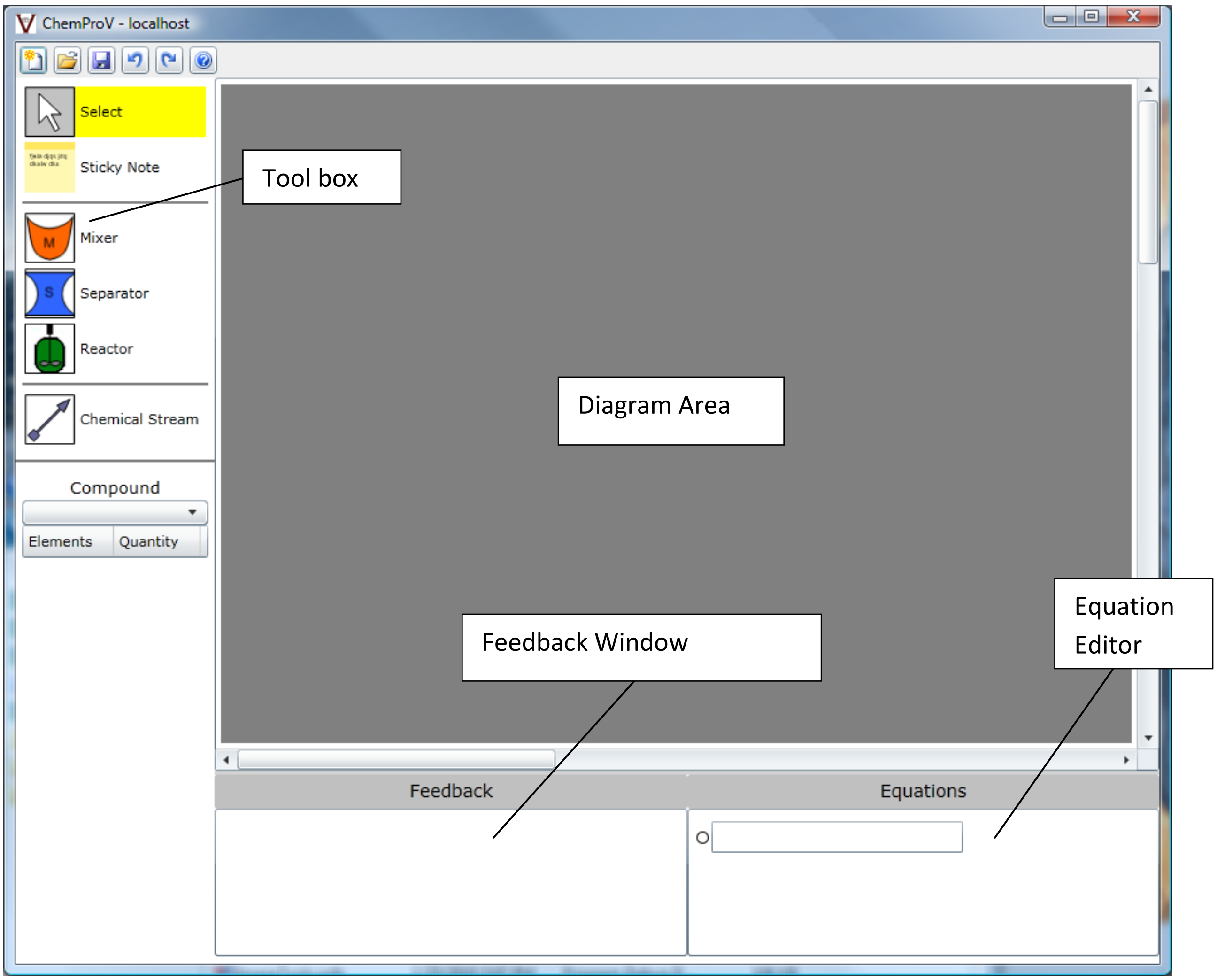
Tutorial

(Please read all instructions aloud as you work through this tutorial.)

In this study, you will be solving problems using Chemical Process Visualizer (ChemProV), a software environment designed to help you solve material balance problems. The main components of the ChemProV application are diagramed below.



Part 1: Basic Operations

ChemProV is a robust application and supports many common interactions, many of which may already be familiar to you. In this section, you will be introduced to these features.

Add/Remove Process Units

Any combination of process units can be added to the diagram area. In the following example, we will add a mixer to the diagram example. To add a mixer, perform the following steps:

1. Click on the "Mixer" icon  in the toolbox.
2. Position the mouse in the diagram area.
3. Click in the diagram area.
4. A Mixer should remain in the diagram area where you clicked.

To remove the mixer from the diagram area, perform the following set of actions:

1. Right-click on the mixer in the diagram area.
2. Select the "Delete" option from the drop-down menu.
3. The mixer should disappear from the drawing canvas.

Note that all actions can be undone/redone by right-clicking on the diagram area and selecting the appropriate action from the drop-down menu.

Part 2: Chemical Reactions

In this study, you will be primarily working with chemical reactions. This section introduces you to ChemProV's "reactor" unit so that you will be familiarized with the process prior to starting the full activity. To begin, perform the following steps:

1. Click on the "reactor" icon  in the toolbox.
2. Position the mouse inside the diagram area.
3. Left click on the diagram area to place the reactor.

Adding Incoming Streams

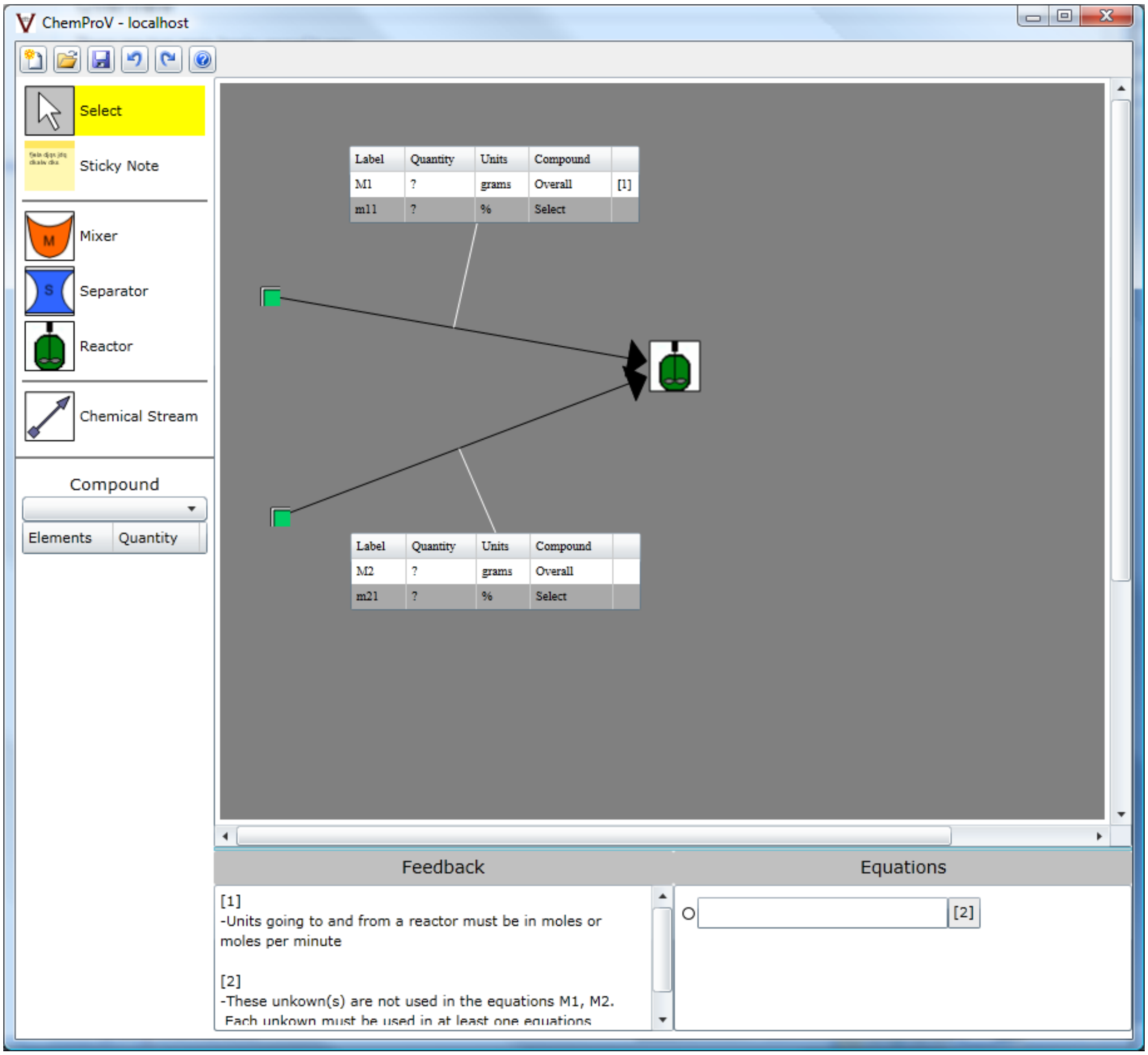
A chemical reactor should now be present on the drawing canvas. By itself, a lone chemical reactor does not accomplish much and is of little interest. However, by adding incoming and outgoing chemical streams, we can begin to convert compounds. Now, let's update our diagram by adding two incoming streams to our chemical reactor. In order to do so, perform the following steps:

1. Select the "Chemical Stream" icon in the toolbox.
2. To the left of the reactor unit in the diagram area, press and hold the left mouse button.
3. While still pressing the left-mouse button, drag the mouse over to the reactor unit.
4. When connected, the chemical stream's head will change from a sink arrow  to a solid black arrow. When this occurs, release the left-mouse button.

a. If you accidentally released the left-mouse button prior to connecting the chemical stream to the reactor, simply left-click on the sink arrow  and drag it to the reactor unit.

5. Repeat steps 1 through 4 to create a second incoming stream

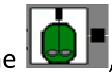
At the end of this process, the diagram area should look like the following picture:



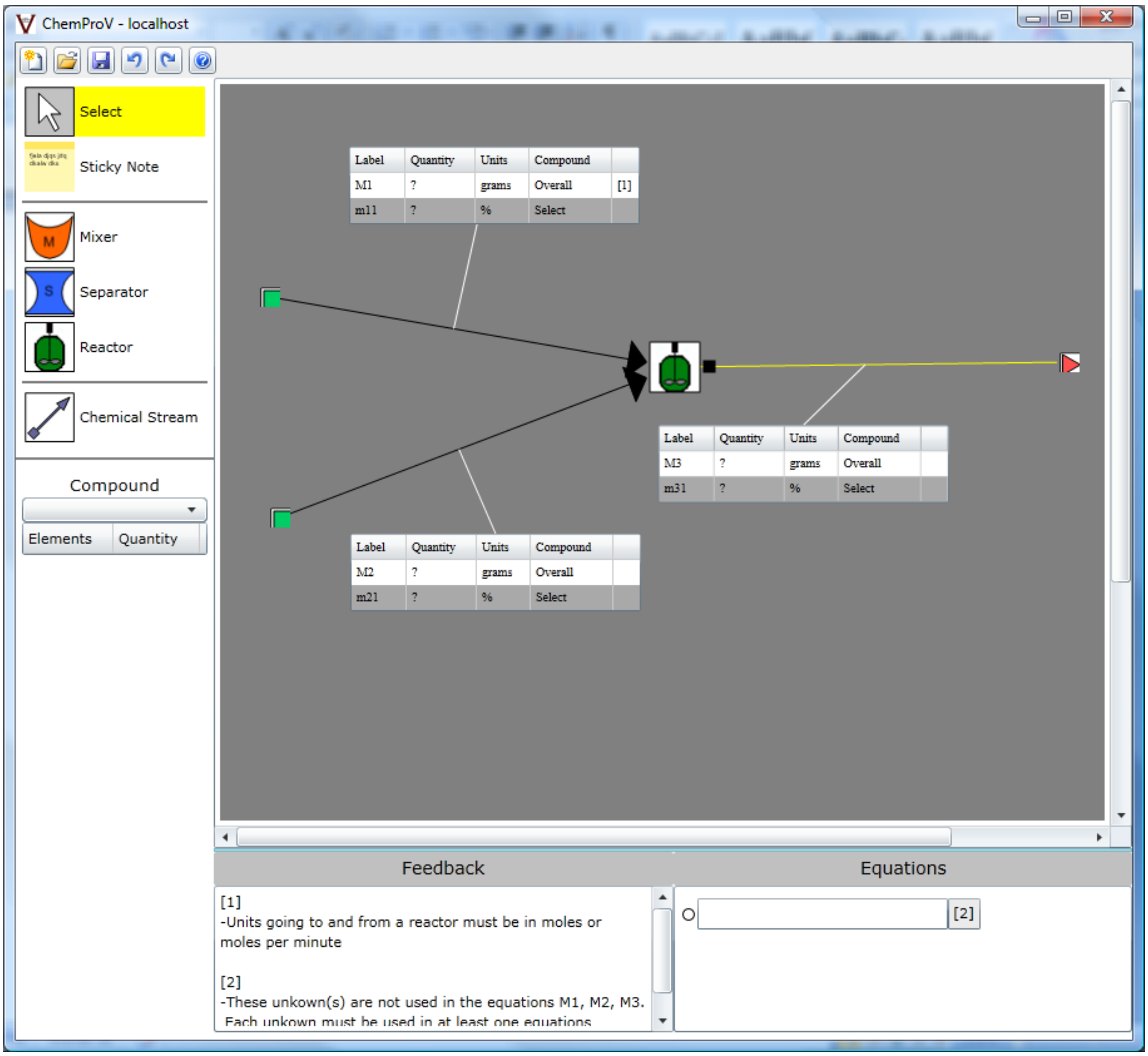
Adding an Outgoing Stream

Having created two incoming streams, we can now create a single outgoing stream that contains the result of our chemical reaction. To create an outgoing stream, perform the following steps:

1. Select the "Chemical Stream" icon in the toolbox.
2. Move the mouse cursor over the chemical reactor unit on the drawing canvas.
3. With the cursor above the reactor unit, press and hold the left-mouse button.
4. While still pressing the left-mouse button down, drag the mouse to the right of the reactor unit.

5. With the stream sufficiently far away from the reactor, release the left-mouse button.
6. When a stream's source is connected to a process unit, a small, black rectangle takes the place of the normal green source .
    a. If your chemical reactor does not have a small, black arrow, like this one , left-click and drag the stream's source onto the reactor and release when the black box appears.

Upon completing the steps above, your diagram should look something like the following:



Stream Properties Tables

Each stream has an associated properties table, pictured at the end of this section. This table has four columns that specify the following information about the components in the stream:

- **Label**: Each stream component has a unique identifying label. By convention, use CAPITAL letters to denote the overall stream label (e.g., "M1") and identical lower-case letters to denote subcomponent labels (e.g., "m11").
- **Quantity**: The quantity of the selected compound in the stream. If unknown, the quantity is represented with a question mark (?).
- **Units**: The units in which the quantity is specified. Other than percentages (%), units of individual compounds must match the overall units.
- **Compound**: The names of the chemical compounds contained in the stream. The first row, labeled "Overall", represents the overall stream and can potentially be composed of several different compounds. In this case, each individual compound must be listed below the "Overall" row.

Label	Quantity	Units	Compound	
M2	?	grams	Overall	
m21	?	%	Select	

Stream Properties Table

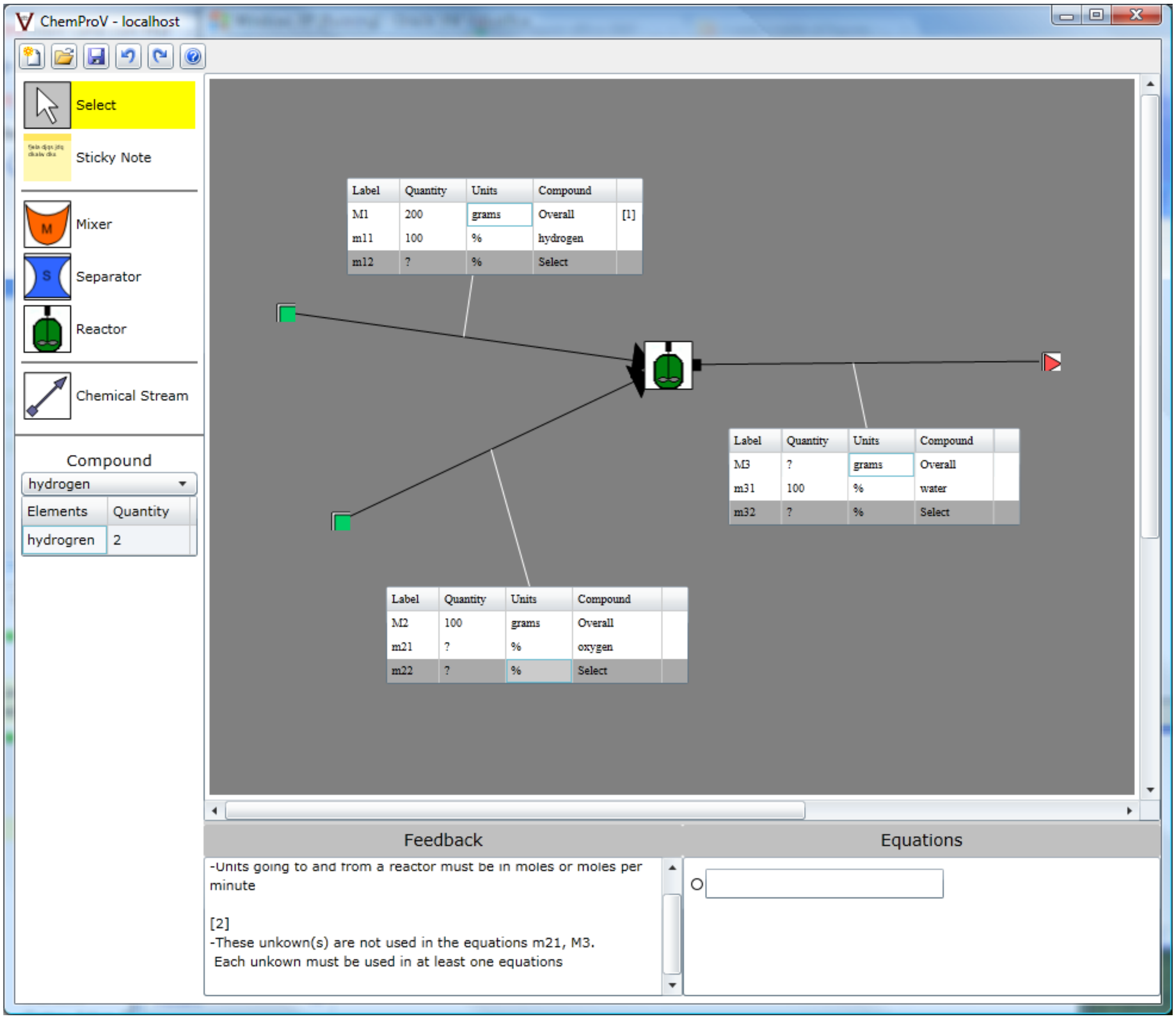
Adding Compounds to the Incoming and Outgoing Streams

As it stands, our reactor is connected to three empty streams. In order to have a chemical reaction occur, we need to supply the reactor with the appropriate compounds. To do so, modify the incoming and outgoing streams:

Note: In the following steps, we are assuming that the properties table with Labels M1 and M2 are attached to the incoming streams and Label M3 is attached to the outgoing stream. In your diagram, this may not be the case. If this occurs, substitute the labels used in your diagram for M1, M2, and M3.

1. Modify the incoming stream, labeled M1, so that it contains hydrogen as one of its compounds.
   a. In our diagram, hydrogen is labeled as m11.
2. Set the overall quantity of M1 to 200 grams
3. Set the quantity of m11 to 100 %
4. Modify the incoming stream, labeled M2, so that it contains oxygen as one of its compounds.
   a. In our diagram, oxygen is labeled as m21.
5. Set the overall quantity of M2 to 100 grams
6. Modify the outgoing stream, labeled M3, so that it contains water.
   a. In our diagram, water is labeled as m31.
7. Set the quantity of m31 to 100%

In this example, we have created a reactor that binds hydrogen to oxygen, outputting water. Note that our reactor is accepting two streams. It would also be possible to create a reactor with a single incoming stream that contains oxygen and hydrogen as subcomponents. At the end of this section, the diagram should look as follows:



Part 3: Addressing Feedback Messages

In examining the feedback window, you will notice that our diagram has a few errors in it. For each feedback message, it is possible to click on the message. Doing so highlights both the message and the source of the message, which is usually a component on the drawing canvas. One of the messages indicates that units going into a reactor must be in terms of moles. Click on this message. Notice that the "[1]" present in the overall row for Table M1 is also highlighted. To fix this error, we must modify our stream tables from the current units (%) to moles:

1. Left-click on the property table's Overall row, opening a drop-down list of options. Note that sometimes a double-click is required to activate the menu.
2. Select "moles" from the drop-down menu in the units column.

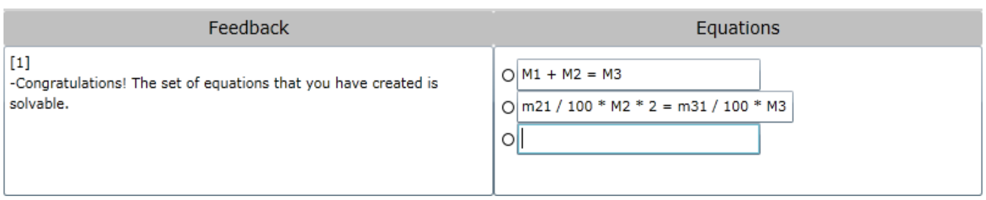
Be sure to change all three overall values from percents to moles. Upon completing this task, you should notice that the moles-related error message in the feedback window is removed. The remaining feedback message is related to the creation of equations, which will be covered in the next section.

Part 3: Creating Equations

The equation editor contains a series of equation text boxes that define unknown relationships present in our process flow diagram. As indicated in the feedback window, we have two unknowns M3 and m31. To account for these unknowns, we need to type in two equations to our equation editor:

1. M1 + M2 = M3
    a. This represents the overall balance
2. m21 / 100 * M2 * 2 = m31 / 100 * M3
    a. This represents the balance moles for oxygen across the incoming and outgoing streams. Note that when working in percents, a value must be first divided by 100 before it is multiplied by the overall stream.

After finishing the final equation, the feedback window should update itself, indicating that the set of equation is solvable.



Remember: As you work through the problem, your goal is to eliminate all of the feedback messages generated by ChemProV.

Finally, while the example process flow diagram constructed in this tutorial includes only a single process unit (a reactor), it is possible to create process flow diagrams consisting of *multiple* process units.

Congratulations! You are done with this tutorial. Please inform the observer that you have completed the tutorial. There is no need to save your work.