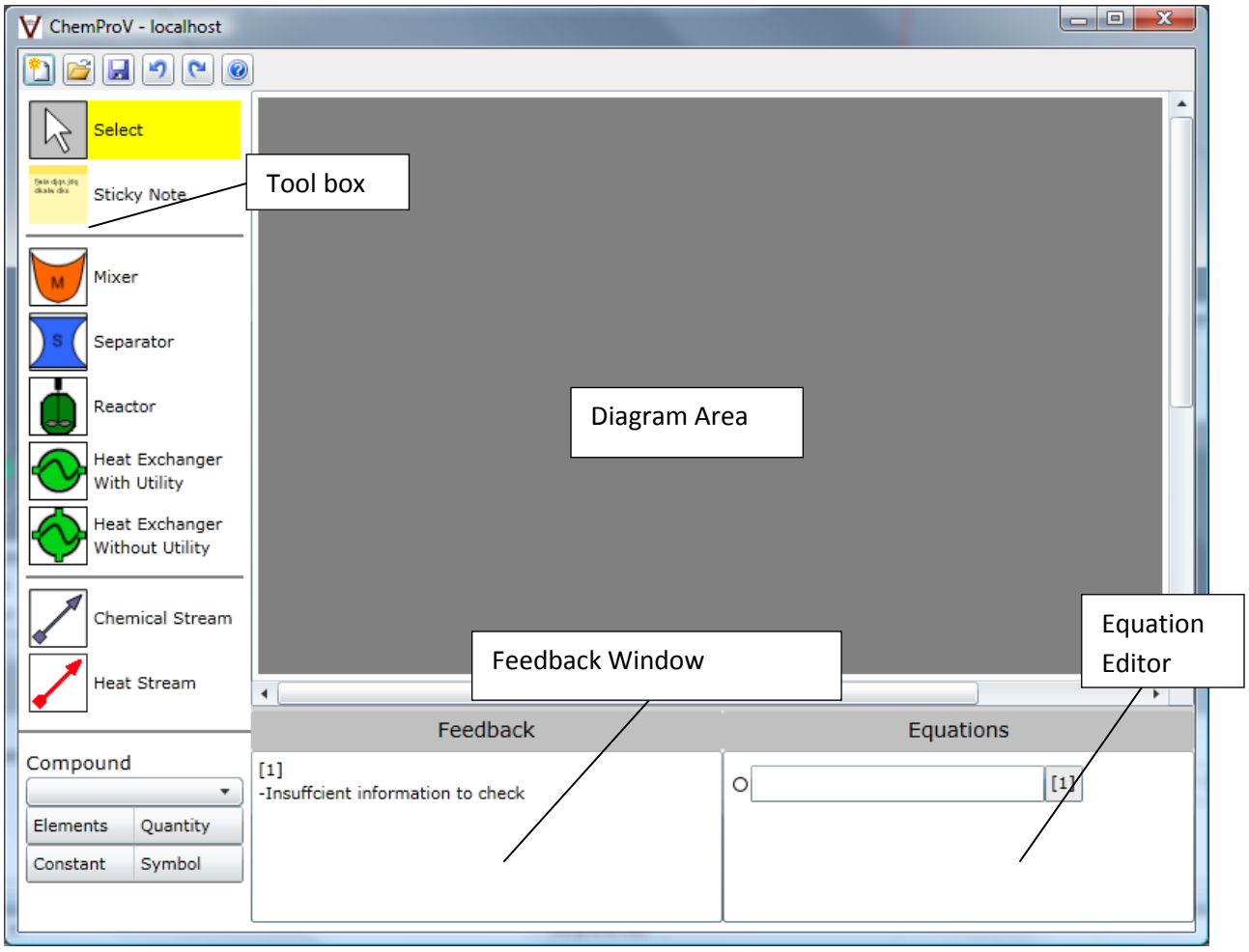
Tutorial

(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:

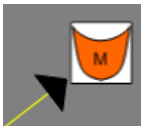
1. Click on the "Mixer" icon in the toolbox.
2. Position the mouse in the diagram area.
3. Click in the diagram area.
4. A Mixer should remain in the diagram area where you clicked.

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

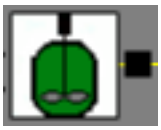
1. Right-click on the mixer in the diagram area.
2. Select the "Delete" option from the drop-down menu.
3. The mixer should disappear from the drawing canvas.

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.

Add/Remove Chemical Streams



Incoming stream


Outgoing stream

Typically, one or more streams can be attached to process units. Streams can either be incoming, denoted by a black arrow, our outgoing, denoted by a black square (see illustrations). The following sequences will take you through the creation of an incoming stream.

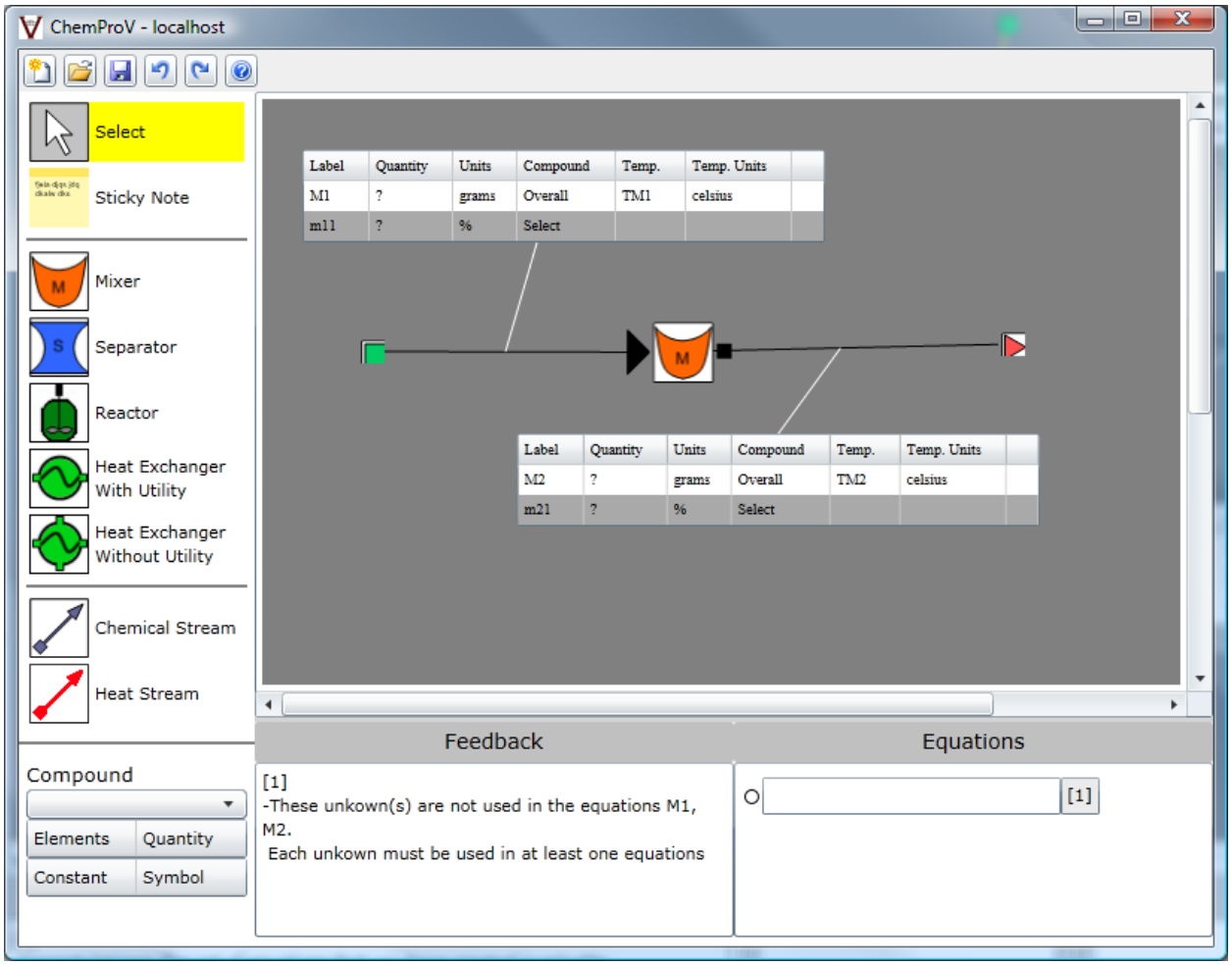
1. Add a new mixer to the diagram area.
2. Select the "Chemical Stream" icon in the toolbox.
3. To the left of the mixer unit in the diagram area, press and hold the left mouse button.
4. While still pressing the left-mouse button, drag the mouse over to the mixer unit.
5. When connected, the chemical 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 mixer, simply left-click on the sink arrow and drag it to the mixer unit

The creation of an outgoing stream is accomplished in a similar manner:

1. Select the "Chemical Stream" icon in the toolbox.
2. Move the mouse cursor over the mixer unit on the drawing canvas.
3. With the cursor above the mixer 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 mixer unit.
5. With the stream sufficiently far away from the mixer, 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 mixer does not have a small, black arrow, left-click and drag the stream's source onto the mixer and release when the black box appears.

Upon completing the above steps, your diagram should resemble the following picture:



Chemical Stream Properties Tables

Each chemical stream has an associated properties table, pictured in the diagram above and at the end of this section. This table has six 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"). Note that you can add customized names by double-clicking on the label cell for a give row.
- **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.
- **Temp. :** The temperature of the stream. If unknown, the temperature is represented by the variable TMx, where "x" is the table's number.
- **Temp. Units:** The units in which the temperature is specified.

Label	Quantity	Units	Compound	Temp.	Temp. Units
M1	?	grams	Overall	TM1	celsius
m11	?	%	Select		

Chemical Stream Properties Table

Part 2: Energy Balances

In this study, you will be primarily concerned with energy balances. This section introduces you to the heat exchanger process unit, which will be needed in the full activity. ChemProV contains two heat exchanger process units:

- **Heat Exchanger With Utility**: Use this process unit to induce a temperature change across a stream. When creating this type of unit, a heat stream is automatically attached to the process unit.
- **Heat Exchanger Without Utility**: Use this process unit to exchange energy between two discreet streams.

Heat Stream Properties Tables

Each heat stream has an associated properties table, pictured at the end of this section. This table has three 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., "Q1").
- **Quantity**: The quantity heat in the stream. If unknown, the quantity is represented with a question mark (?).
- **Units**: The units in which the quantity is specified.

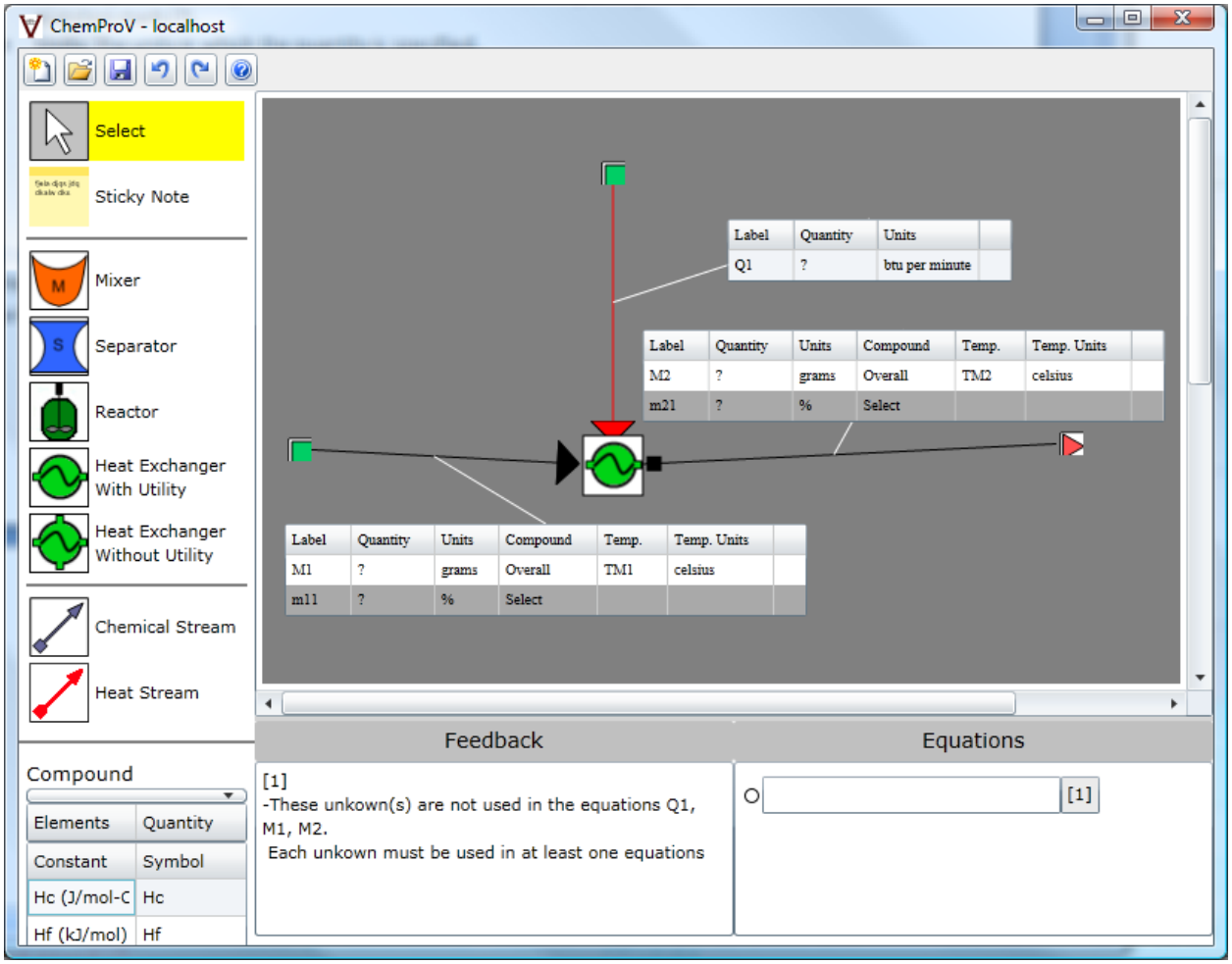
Label	Quantity	Units
Q1	?	btu per minute

Heat Stream Properties Table

Using Heat Exchangers

Before beginning this section, please create a new process flow diagram by clicking on the "New File" icon in the top-left corner of the program. Now, place a new "Heat Exchanger **With** Utility" onto the diagram area. Note that when placed, ChemProV automatically has you place the exhanger's corresponding heat stream. Anchor this stream above the heat exchanger. Finally, add an incoming and

outgoing chemical stream to the heat exchanger. When complete, your diagram area should look like the following picture:



Adding Compounds to the Incoming and Outgoing Streams

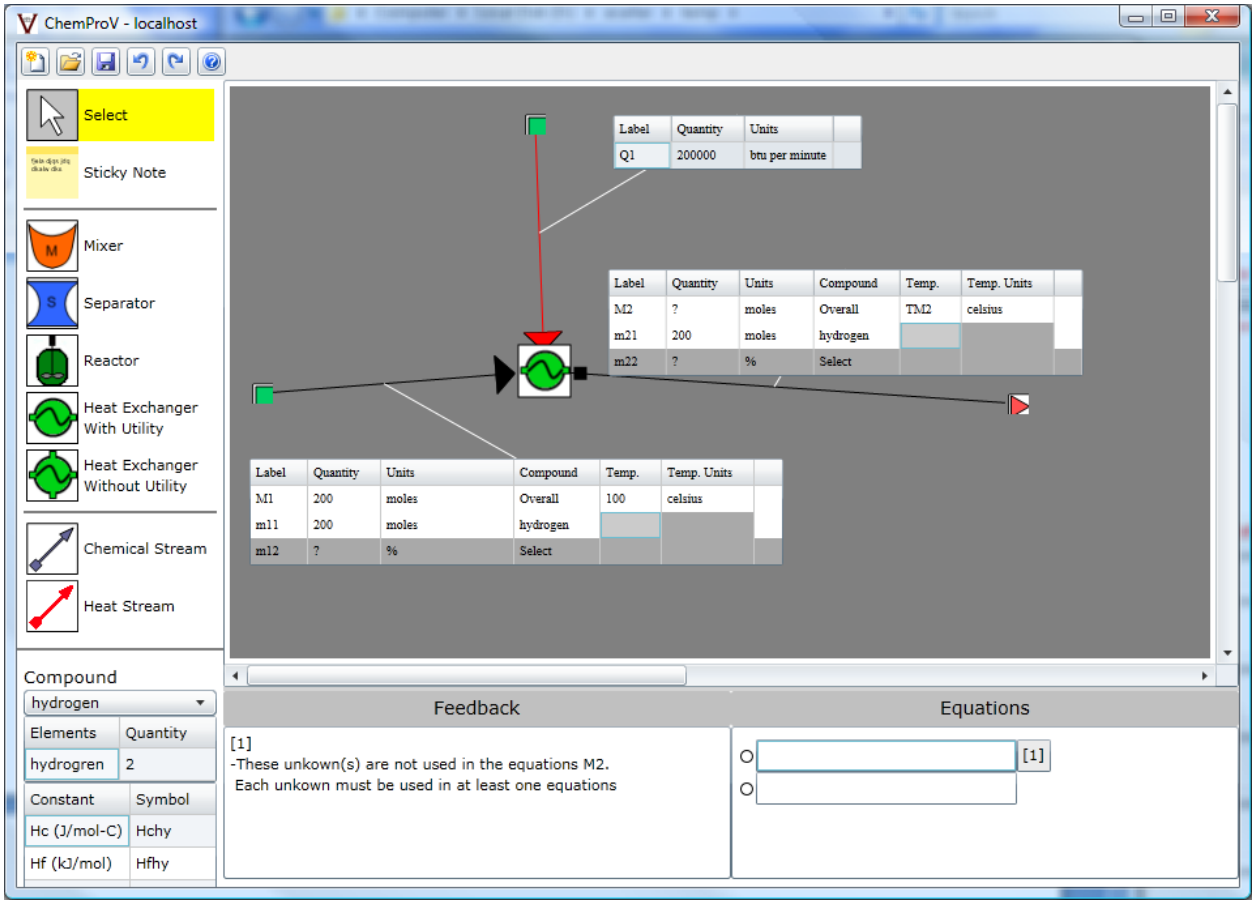
As it stands, our heat exchanger is connected to two empty streams. We need to supply the streams with appropriate compounds. To do so, modify the incoming and outgoing streams:

Note: In the following steps, we are assuming that the properties table with Label M1 is entering the heat exchanger and Label M2 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 M and M2.

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 moles.
3. Set the temperature of M1 to 100 degrees Celsius.
4. Set the quantity of m11 to 200 moles
5. Modify the outgoing stream, labeled M2, so that it contains hydrogen.
    a. In our diagram, hydrogen is labeled as m21.
6. Set the overall quantity of M1 to 200 moles

7. Set the quantity of m21 to 200 moles.
8. Set the quantity of the heat stream Q1 to 200,000 joules

Upon entering the data, your diagram should resemble the following picture:

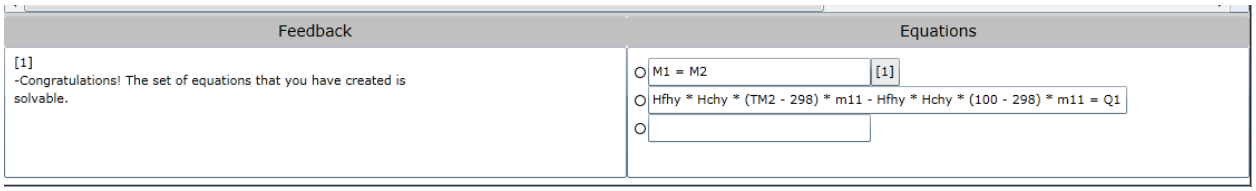


Part 3: Creating Equations

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: M2 and MT2. To account for these unknowns, we need to type in two equations to our equation editor:

1. M1 = M2
    a. This represents the overall balance
2. Hfhy * Hchy * (TM2 - 298) * m11 - Hfhy * Hchy * (100 - 298) * m11 = Q1
    a. This represents the energy transfer across the heat exchanger. A list of heat constants for each compound in the PFD can be found on the left-hand side of the screen.

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



Part 4: Addressing Feedback Messages

ChemProV continually tracks the validity of your PFD and displays any errors in the feedback window area. This section demonstrates how to identify and address specific feedback messages.

PFD Related Messages

Let's create a error in our process flow diagram by changing the compound of m11 from hydrogen to methane. Notice that when this occurs, ChemProV supplies a corresponding feedback message indicating that methane is specified in the incoming stream, but not in the outgoing stream. The number "[1]" generated next to the feedback message corresponds to the "[1]" present in the overall row for table M1. To fix this message, change m11 back to hydrogen. Notice that the error message disappears.

Equation Related Errors

Due to the freeform nature of the equation editor, it is not uncommon to make labeling errors. To test this, alter your first equation (M1 = M2) by rewriting "M2" as "m2". Notice that the feedback window indicates that the term "m2" is undefined. To fix this message, change "m2" back to "M2". Again, the feedback message disappears.

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.