Cogeneration Facility HYSYS Simulation

Process Measurements Fall 1998 Robert P. Hesketh, Stephanie Farrell and C. Stewart Slater Chemical Engineering College of Engineering

In this exercise you will simulate the two heat exchangers in the cogeneration unit using a chemical process simulation package from Hyprotech Inc. This program is used by industry to design and simulate process plants such as oil and gas refineries, chemical and pharmaceuticals production facilities. A typical sampling of well-known companies using this software are given below:

- DuPont, Eastman Kodak, Monsanto, Hoechst Celanese, Rohm & Haas
- Shell, Amoco, Exxon Chemical, Olin, Conoco, Phillips
- Foster Wheeler, Arthur D. Little, Ballard, Koch
- Hoffman LaRoche, International Flavors and Fragrances,

This software is written in C++ which is a language that you will learn next semester. The cost of this software is approximately \$45,000 for the dynamic version and \$20,000 for the steady-state version. This price is for only one user! For more information on Hyprotech go to www.hyprotech.com

You have just returned from the Rowan Cogeneration Plant tour with a table of readings for the water flow in the process given below. Using your measurements of temperature, pressure and flowrate we will simulate two heat exchangers. The overall process for this simulation is to

- Select a thermodynamics package that describes the physical and chemical properties of water
- Select two heaters
- Define all required inputs and output streams. Specify required values of temperature, pressure, flowrate and chemical concentration.

Start your computer:

Start the computer by pressing ctrl alt del simultaneously.

Log in following procedure given to you in class.

Make sure your server is 1ROWANENG for the domain

Go to Start; Engineering Apps; and choose HYSYS

This package will take about a minute to start up and when complete you will see the screen given above.

To start a new case click on the white page icon or use the commands File New Case.

Please note that the manuals can be viewed by mapping the drive <u>\\ENGNET1\OPENAREA</u> and going to "Openarea on 'Engnet1'" \Hysys Help/Menu.pdf



The result will be the following menu screen to choose a thermodynamic property package. You will learn more about these packages in your thermodynamics and chemical engineering thermodynamics courses. We will use the American Society of Mechanical Engineers (ASME) steam tables for our property package.

Choose the button Add...

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- 1. Choose Miscellaneous Types
- 2. Choose ASME Steam
- 3. Press the Components tab
- 4. Add Pure H₂O by selecting H2O and pressing the Add Pure button
- 5. Press the <u>C</u>lose button for this screen
- Press the Enter Simulation Environment... Button (see figure above)

You should now see the following screen. In the green screen you will construct a process flow diagram (PFD) of the two cogeneration plant heaters. The pictures of equipment shown to the right of the green screen contains the equipment that you will add. We will add two

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heaters which are symbolized by a grey circle with a red jagged arrow passing through them.

- Select the heater by first clicking on it and then release. Move the mouse to the green PFD screen and click a second time. Note this is not the traditional drag and drop!
- Double click on the heater icon and the following menu will result. Notice that a red warning sign appears telling you what is required: "Requires a feed stream." The red stream is the hot exhaust gases and the blue stream is the water
- 3) Fill out this menu as follows:
 - a) <u>N</u>ame: Economizer
 - b) Inlet: feed water
 - c) Energy: heat from boiler exhaust
 - d) Outlet: boiler inlet water
- 4) Choose Work Sheet tab





- 5) To enter your readings of temperature, pressure and flowrate for the economizer **double click** on the stream name, feed water. Type in your value of Feed Water Temperature. I will use 215°F for this example. Type in the number, a space and the letter F. Hit return and notice that it converts the units to SI automatically!
- 6) Change your units from SI to American engineering by first
 - a) pressing the Close button on each of the two screens.
 - b) Go to the command Tools, preferences
 - c) Choose the Units tab
 - d) Select Field
 - e) Press close.
- 7) Save your case in your personal drive by executing the commands File, Save choose your drive letter and give a name to the case.
- 8) Continue entering the stream variables for the feed water stream.
 - a) Double click on the heater.
 - b) Double click on the name of the stream "feed water"
 - c) Enter feed water pressure. I will use 255 psig.

Notice that the software automatically converts the pressure to absolute pressure by adding 14.696 psi to the value

- to get 269.696 psia. d) Enter the mass flowrate of the feed water. I will use 11,500 lb_m/hr.
- e) Double click on the value of the mass flowrate that you have just entered. This brings up a screen titled "Input Composition for Stream feed water" to specify the chemical components. Enter one and press the OK button. In this case we only have one nt and that compo chemic many components to specify

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and this becomes one of the most important screens for input and output.

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Temperature [F]	215.0000	<empty></empty>	<empty></empty>	
Pressure [psia]	269.6960	<empty></empty>	<empty></empty>	
Molar Flow [lbmole/hr]	638.3534	<empty></empty>	638.3534	
Mass Flow [lb/hr]	11500.0000	<empty></empty>	11500.0000	
LiqVol Flow [barrel/day]	789.0266	<empty></empty>	789.0266	
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Temperature [F]	215.0000	<empty></empty>	345.0000	
Pressure [psia]	269.6960	<empty></empty>	269.6960	
Molar Flow [lbmole/hr]	638.3534	<empty></empty>	638.3534	
Mass Flow [lb/hr]	11500.0000	<empty></empty>	11500.0000	
LiqVol Flow [barrel/day]	789.0266	<empty></empty>	789.0266	
Heat Flow [Btu/hr]	-7.6625e+07	1.5297e+06	-7.5096e+07	
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- f) Click on the Close button to close the Feed Water screen.
- 9) Enter the temperature and pressure for the boiler inlet water stream.
 - a) Double click on the stream name "boiler inlet water"
 - b) Enter the boiler inlet water temperature. I will use 345°F.
 - c) Enter the same pressure as the feed water pressure of 255 psig. Remember the final value will be 269.696 psia!

You will notice after you enter these two values of temperature and pressure, the remaining values of these streams will be calculated by HYSYS. The values in blue are the ones that you have entered and the values in black have been calculated by HYSYS. The value of the heat duty on the economizer, $Q_{economizer}$, is given as the Heat Flow of the energy *stream* "heat from boiler exhaust." Using the values I have entered for this handout the heat duty (heat flow) is 1.53×10^6 Btu/hr. Or switching the units to SI (Tools, preferences, Units, SI) the heat duty is 1.62×10^6 kJ/hr. The value of heat duty you have obtained using your readings should be nearly identical to the value you calculate in your homework problem.

d) Close the Economizer screen by clicking the Close button.

Boiler Heater Unit

Now insert the heater unit that simulates the boiler.

- 10) Select the heater by first clicking on it and then release. Move the mouse to the green PFD screen and click a second time. Note this is not the traditional drag and drop!
- 11) Double click on the heater icon and the following menu will result. Notice that a red warning sign appears telling you what is required: Requires a feed stream. The red stream is the hot exhaust gases and the blue stream is the water.
- 12) Fill out this menu as follows:
 - a) <u>N</u>ame: Boiler
 - b) For the inlet water stream to the Boiler unit you do not have to type the stream name in. Use the pull down menu to see the available streams. In this case there is only one stream available: "boiler inlet water." Select this stream by clicking on it.
 - c) Energy: heat from turbine exhaust
 - d) Outlet: Steam
- 13) Choose the Work Sheet tab and enter your readings from the plant similar to that shown at right.



14) Notice that the boiler feed stream is already specified from the output of the economizer.

15) Specify the required variables for the Steam stream

- a) The steam from the boiler is *saturated* steam. You will learn more about saturated steam in your thermodynamics courses. To specify saturated steam in this simulation you will set the Vapour (that's English or Canadian) to a value of exactly 1.
- b) Enter the steam pressure. I will use 150 psig. Notice that the software automatically converts the pressure to absolute pressure by adding 14.696 psi to the value to get 164.696 psia. Also notice that all other stream values are calculated and the heat duty is determined. Notice that the temperature of the steam, T_s, shown on your simulation (that you obtained using your steam pressure reading) should be identical to the value you will calculate in the homework.
- c) The heat duty (heat flow) for the boiler obtained from the simulation may be higher than the value that you calculate in your homework. The value in your homework uses the

mass flowrate of steam which may be different from the mass flowrate of the feed water stream.

- Add two summary tables to your PFD, by right clicking your mouse on a heater, and selecting Show Table.
- e) Close the Boiler screen by clicking on the Close button.

Printout two HYSYS workbook Specsheets. One should be in SI and the other in field

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units so that you can use these results to guide you in your homework solution. To print a specsheet:

- a) Select the workbook by pressing the toolbar button as shown in the figure below.
- b) Select File, Print,
- c) Choose All Pages Compact.
- d) Preview it

Also printout your process flow diagram, (PFD) by choosing the print command while the PFD is active.

Homework must be submitted one week from today at 8:00 a.m.

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