Aspen OnLine

Tutorial

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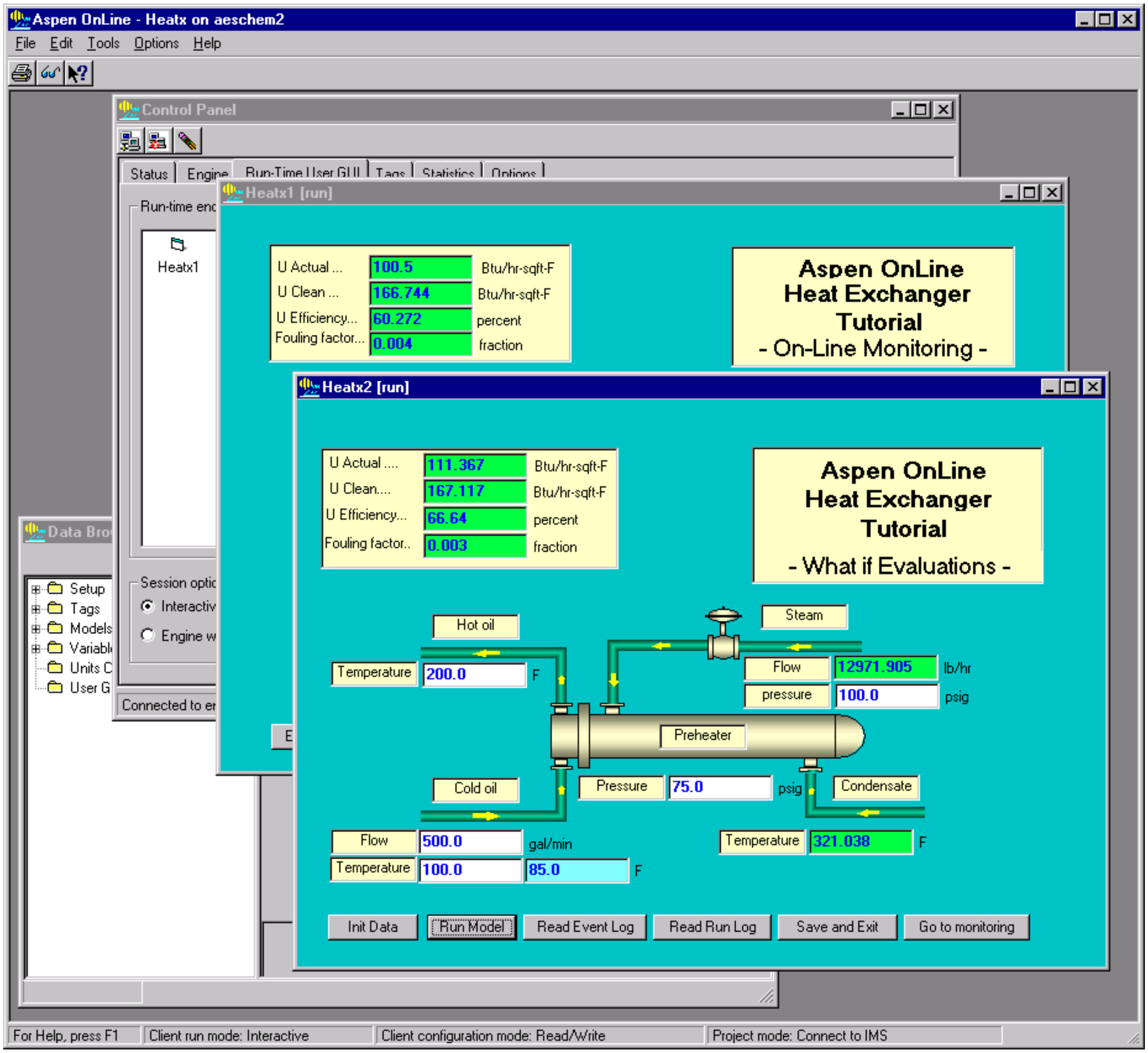


Aspen OnLine - Heatx on aeschem2

Heatx1 [run]

U Actual ...	100.5	Btu/hr-sqft-F
U Clean ...	166.744	Btu/hr-sqft-F
U Efficiency...	60.272	percent
Fouling factor...	0.004	fraction

Aspen OnLine Heat Exchanger Tutorial - On-Line Monitoring -

Heatx2 [run]

U Actual	111.367	Btu/hr-sqft-F
U Clean....	167.117	Btu/hr-sqft-F
U Efficiency...	66.64	percent
Fouling factor..	0.003	fraction

Aspen OnLine Heat Exchanger Tutorial - What if Evaluations -

Hot oil: Temperature 200.0 F

Steam: Flow 12971.905 lb/hr; pressure 100.0 psig

Preheater: Pressure 75.0 psig

Cold oil: Flow 500.0 gal/min; Temperature 100.0 / 85.0 F

Condensate: Temperature 321.038 F

For Help, press F1 | Client run mode: Interactive | Client configuration mode: Read/Write | Project mode: Connect to IMS

Introduction

The user is strongly urged to practice with this tutorial before attempting to implement an on-line application. The time spent in practice will be well rewarded when it comes time to implement an actual on-line model.

The objective of this tutorial is to take the user step-by-step through the implementation of an on-line model so that each step of the implementation is clearly understood. There are three major connected elements that must function properly. As shown in Figure 1, these include:

- the plant Information Management System (IMS) or Distributed Control System (DCS)
- the engineering model
- the Aspen OnLine system

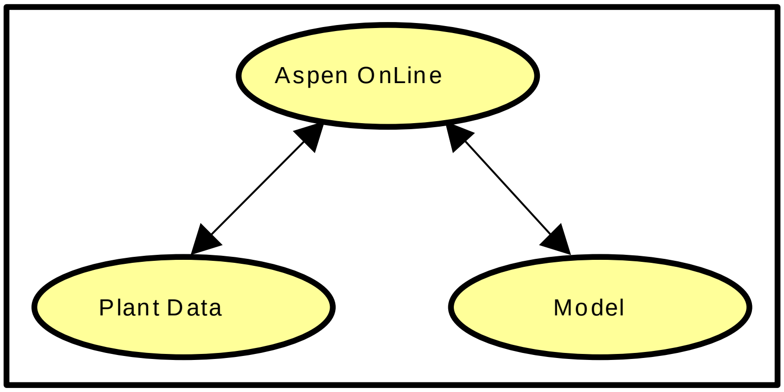


Figure 1: The Three Major System Elements

The first step in the implementation is to make sure that the connection to the plant data is working properly. The second step is to make sure the model is working correctly. The third step involves configuring Aspen OnLine to support an on-line model. The steps for setting up an Aspen OnLine application include:

- Creating the on-line project
- Configuring the engine
- Developing the graphical user interface
- Testing
- Placing the system on line

The above tasks can be performed using Aspen OnLine client programs either remotely or locally. In this tutorial one computer will serve as both the client and the server. The operating system for the Aspen OnLine server and client must be Windows NT 4.0 SP6 or Win2K with SP2. In this tutorial Windows NT will be the operating system for both Aspen OnLine client and server.

Description of the Heat Exchanger Model

The model in this tutorial is of a steam-heated oil preheater. It is a fully specified two-pass horizontal heat exchanger with steam on the shell side and oil in the tubes. The model acts as an on-line monitor of the preheater heat transfer efficiency and fouling factor. By tracking these factors over time, cleaning can be scheduled on an optimal basis. A simplified diagram of the exchanger is shown in Figure 2 with the input values used in this tutorial.

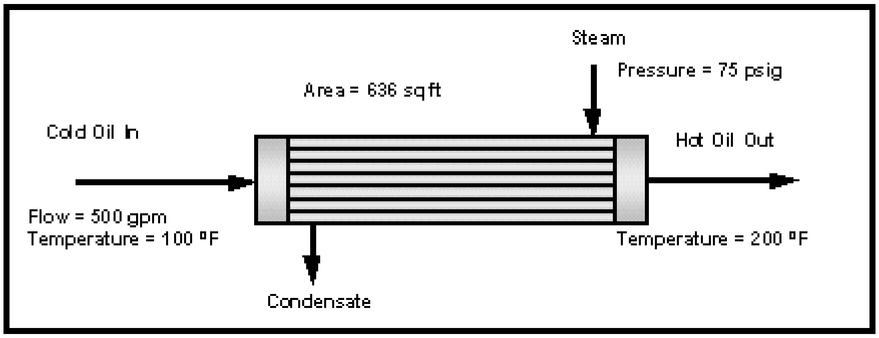


Figure 2: Heat Exchanger with Known Values

The flow rate and the inlet and outlet temperatures for the oil are known. This determines the heat load, Q, on the exchanger. The known value of steam pressure on the shell side allows its temperature to be determined, and thus the log mean temperature difference, LMTD. With a known area A, the heat transfer coefficient U can be determined from the equation

$U = Q / (A * LMTD)$

In practice the heat transfer coefficient, U, is strongly affected by the flow rate of oil and steam, and the operating temperature, which changes the thermal transfer characteristics of the oil. This makes it very difficult to determine the true extent of the surface fouling. However, an Aspen Plus model of the exchanger can be used to calculate an actual and a theoretical (clean exchanger) heat transfer coefficient, both of them based on the actual flow rates and operating conditions. From the ratio of the actual to the theoretical heat transfer coefficient one obtains a heat transfer efficiency factor,

$U_{eff} = U_{act} / U_{theo}$

The heat transfer efficiency factor, U_{eff}, provides a more accurate method for measuring the loss of heat transfer efficiency over time.

The relationship of the fouling factor, FF, and the actual and theoretical values of the heat transfer coefficient is given to close approximation by the relationship

$1/U_{act} = 1/ U_{theo} + FF$

This is a simplified representation of the actual calculations performed in Aspen Plus. The values displayed on the GUI are from the Aspen Plus model of the exchanger.

Dual Objective On-line Project

This tutorial will demonstrate the use of an Aspen OnLine project to accomplish two application objectives. In its primary use, as a plant equipment monitor, values of heat transfer efficiency and fouling factor will be calculated periodically. This provides a measure of the deterioration in heat exchanger performance and enables better decisions as to when to take corrective maintenance action. Values of heat transfer efficiency calculated by Aspen OnLine in the equipment monitoring mode will be sent to the plant IMS and stored there for trending and further analysis.

The project will also be used to perform evaluations (what-if analysis) of the changes in steam demand caused by varying cold oil inlet temperatures. This what-if application also illustrates the procedure for entering user values at run-time via the graphical user interface.

Taking this idea further, it can be seen that an on-line project can be developed to address multiple needs or opportunities to improve plant operations. Some representative types of Aspen OnLine applications are described in the Aspen OnLine User Guide.

Software Requirements

The process models are developed with Aspen Plus. Aspen OnLine is not used to develop the process models; rather Aspen OnLine uses a fully developed Aspen Plus model and places it “on-line” with actual plant data. Aspen Plus needs to be installed in the same computer as the Aspen OnLine server.

This tutorial requires this software:

- Aspen Plus 2004.1 or later
- Aspen OnLine 2004 or later
- Aspen Process Explorer 3.1 or later from Aspen Manufacturing Suite (recommended but optional)
- Microsoft Excel 2000 or later

In this tutorial Aspen InfoPlus 21 (IP.21) is the plant IMS and Aspen CIM-IO Interfaces is the interface between the server and the plant IMS. The Aspen Process Explorer is optional; it permits easy transfer of tag information from IP.21 to Aspen OnLine. However, this tag information can be entered manually if Process Explorer is not available.

In addition, Microsoft Excel 2000 is needed. The operating system is Windows 2000 or later.

Step-by-Step Instructions

The instructions in this tutorial provide step-by-step instructions showing how the heat exchanger problem is defined and placed on-line. There are three columns in each table. The column on the left describes the action of the user. The column in the middle shows the title of the active display that should appear if the user has taken the correct action. This column shows a new display title only when the active display changes. The column on the right describes the results of the action. Characters and words shown in **bold** are either read from or written to the screen.

Pictures of the Aspen OnLine Screens

Many figures are included in this tutorial to show Aspen OnLine screen sequences and how each screen should appear if properly configured. Some of the data the user will introduce in the development of the on-line heat exchanger project will be provided from these figures.

Technical Support

AspenTech customers with a valid license and software maintenance agreement can register to access the online AspenTech Support Center at:

http://support.aspentech.com

This Web support site allows you to:

- Access current product documentation
- Search for tech tips, solutions and frequently asked questions (FAQs)
- Search for and download application examples
- Search for and download service packs and product updates
- Submit and track technical issues
- Send suggestions
- Report product defects
- Review lists of known deficiencies and defects

Registered users can also subscribe to our Technical Support e-Bulletins. These e-Bulletins are used to alert users to important technical support information such as:

- Technical advisories
- Product updates and releases

Customer support is also available by phone, fax, and email. The most up-to-date contact information is available at the AspenTech Support Center at **http://support.aspentech.com**.

2 Project Initialization

Initialization Steps

Project initialization involves the steps that need to be performed before development activities begin. These steps include:

- Testing the model using Aspen Plus User Interface
- Verifying that the connection to plant data is operational
- Creating the Project

After the project is created there are three additional steps to complete. These include:

- Project specifications required by Aspen OnLine engine program
- Configuring the Graphical User Interface
- Testing the Project

These steps are described in detail in the following sections.

Load Model and Verify Operation Under Aspen Plus

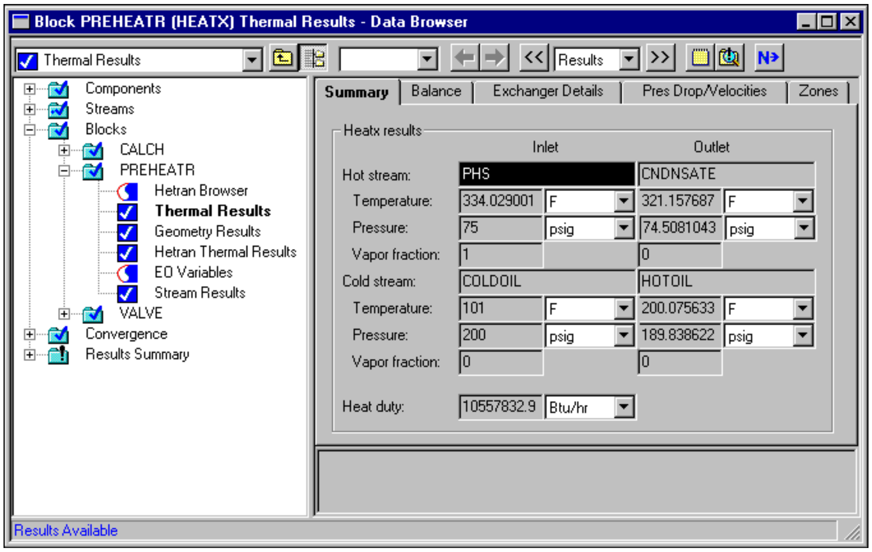
An Aspen OnLine project can make use of multiple models with each model being used to fulfill a different objective. This tutorial requires only a single model. However, to illustrate how two models can be used, two copies of the same model will be used, one for each of the two objectives of this example application.

There is a Documentation subdirectory in the directory where Aspen OnLine is installed. Copy heatxn1.bkp from the Documentation directory to any temporary model test folder. Open the heatxn1.bkp file using Aspen Plus User Interface. If the model cannot be successfully loaded, there is a problem with Aspen Plus that needs to be corrected before proceeding.

When you load the file, Aspen Plus may display the **Connect to Engine** dialog box. In most cases, the default option to run the Aspen Plus engine on the *Local PC* is correct.

Important: In order to ensure proper operation of Aspen Plus under Aspen OnLine, set the proper settings for connecting to the Aspen Plus engine and select the **Save as Default Connection** checkbox, then click **OK**.

Run the model to ensure that it is working correctly. A model that is to be deployed in an on-line application should be tested over the entire range of anticipated operating conditions. A copy of the Summary Report page for the Preheater is shown in Figure 3. These outputs correspond to the inputs shown in Figure 2. A comparison of your computed results with these values should confirm that the model is working correctly. Take a few minutes to familiarize yourself with the model, its inputs, and its outputs. When finished, exit from the Aspen Plus User Interface without saving the results of the calculations.



Heatx results

	Inlet		Outlet	
Hot stream:	PHS		CNDNSATE	
Temperature:	334.029001	F	321.157687	F
Pressure:	75	psig	74.5081043	psig
Vapor fraction:	1		0	
Cold stream:	COLDOIL		HOTOIL	
Temperature:	101	F	200.075633	F
Pressure:	200	psig	189.838622	psig
Vapor fraction:	0		0	
Heat duty:	10557832.9	Btu/hr		

Figure 3: Aspen Plus Summary Report for the Preheater

Verify Connection to Plant Data

This tutorial has been developed using the DCS tags listed below. For replicating the tutorial in an on-line mode, it is necessary to create "plant tags" with the same names in your plant data server (Aspen CIM-IO Interfaces accessible IMS or DCS). However, should you choose not to add these tags to your IMS/DCS or should you not have access to an IMS/DCS you may still proceed with the tutorial by opting to work with Aspen OnLine in a "Test" mode, i.e. without connecting to plant data. In this case, the instructions for Aspen CIM-IO Interfaces configuration and Aspen CIM-IO Interfaces test can be ignored. The values given below would be entered directly as test values in the CIM-IO form as described later.

For simplicity, the values for the tags below can be entered in the IMS/DCS as static values.

Tag	Value	Units
HX-F-101	500	gpm
HX-T-101	100	F
HX-T-102	200	F
HX-P-401	100	psig
HX-P-301	75	psig

Once the plant tags have been created, test access to them using Aspen CIM-IO Interfaces. Aspen CIM-IO Interfaces is the AspenTech software interface to the plant IMS and has been loaded along with Aspen OnLine. It transfers information between the Aspen OnLine Engine in the Aspen OnLine server computer and the plant IMS in the IMS server computer. Use the Aspen CIM-IO Interfaces test function to make sure that this interface is operating correctly, and that IP.21 is running.

The device, node, and service names used in this tutorial are for an IP.21 system on the AspenTech network. The Plant Tags used in this heat exchanger example are in this server.

Logical Device Name:	IOSETCIM200
Node Name for the IMS server:	LIH1
Services:	CIMIOSETCIM_200 CIMIOSETCIMH_200

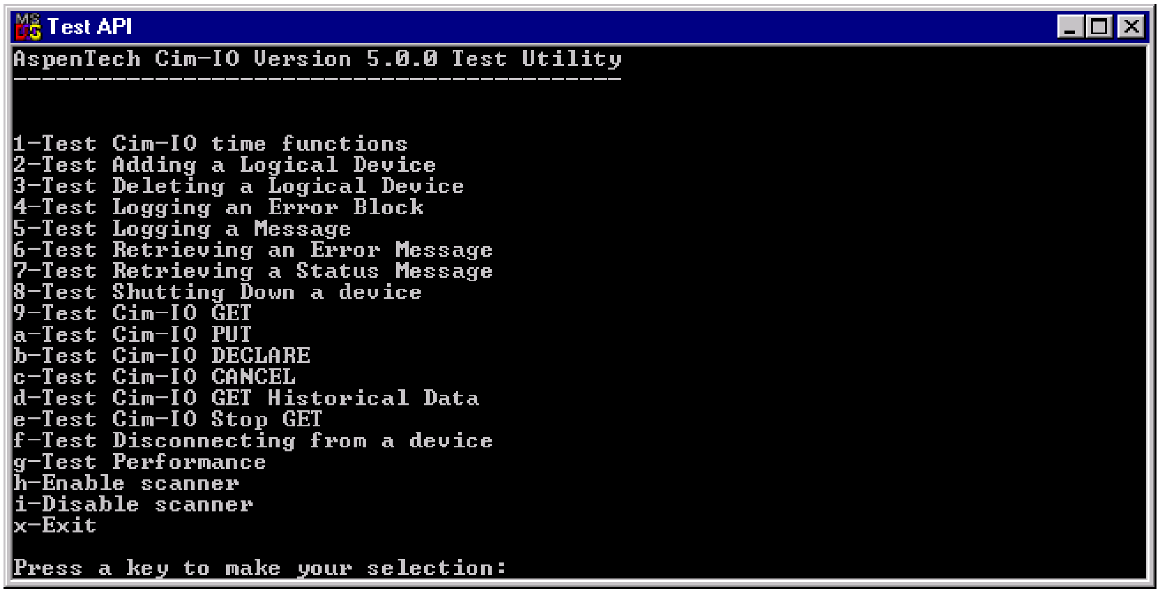
The names in your system could be different. Consult with your System Manager to determine what names to use.

The following table provides a step-by-step list of instructions to test access to plant data from an IP.21 system. You will need to refer to the respective Aspen CIM-IO Interfaces device interface manual for other systems. The first screen is shown in Figure 4. The objective of the test is to verify that a communication link to the plant data source has been established. A **GET successful** message at the end of this test indicates that the connection to the plant data is working correctly. If the test fails, then verify that both the IP.21 and Aspen OnLine machines have been properly configured. Refer to the Aspen OnLine User Manual section on Configuration, or consult the Information Management Systems manager at your site.

Verify Connection to Plant Data

Button Sequence	Title of Active Screen	Result
Click **Start** button on Status bar.	Desktop	Activates workstation menu
Point to **Programs | AspenTech | Advanced Process Control & Optimization | Aspen Cim-IO Interfaces** and click **Test API**.	CIM-IO Test	Press a key to make your selection:
Enter **9**		Please enter logical device name[]:

Button Sequence	**Title of Active Screen**	**Result**
Enter **IOSETCIM200**		Please enter unit number[]:
Enter **1**		Please enter number of tags[]:
Enter **1**		Please enter priority <1=HIGHEST 9=LOWEST>[]:
Enter **1**		Please enter timeout in seconds[]:
Enter **1**		Please select access type[]:
Enter **1**		Please enter list id[]:
Enter **1**		Please select tagname entry option[]:
Enter **1**		Please enter tagname 1:
Enter **HX-F-101**		Please select data type for tag 'HX-F-101':
Enter **1**		Please select device data type for tag 'HX-F-101' Press RETURN for default:
Press **Return** (or **Enter**)		GET successful Tagname: hx-f-101 Type: REAL Device Data Type: REAL Value= 500.000000 Timestamp: Wed 16 14:27:59 1998 Status is no status Facility=19 Driver Status= 0 Please press RETURN to continue…
Press **Return** (or **Enter**)		Press a key to make your selection:
Enter **x**	Desktop	



```
AspenTech Cim-IO Version 5.0.0 Test Utility
-------------------------------------------


1-Test Cim-IO time functions
2-Test Adding a Logical Device
3-Test Deleting a Logical Device
4-Test Logging an Error Block
5-Test Logging a Message
6-Test Retrieving an Error Message
7-Test Retrieving a Status Message
8-Test Shutting Down a device
9-Test Cim-IO GET
a-Test Cim-IO PUT
b-Test Cim-IO DECLARE
c-Test Cim-IO CANCEL
d-Test Cim-IO GET Historical Data
e-Test Cim-IO Stop GET
f-Test Disconnecting from a device
g-Test Performance
h-Enable scanner
i-Disable scanner
x-Exit

Press a key to make your selection:
```

Figure 4: Initial Aspen CIM-IO Interfaces test screen

3 Create a New Project

Steps to Create a New Project

Once the process model and connection to plant data source have been tested, the on-line project can be created. The project creation step in Aspen OnLine will set up the file-structure for the project as well as an blank project database, config.mdb, in which configuration information can be entered at the time of project development. Three sub-folders will be created in the chosen project folder.

Aspen OnLine Project Manager program is used to manage Aspen OnLine projects including project creation. The following table provides a list of steps to follow to create a project.

Create New Aspen OnLine Project

Button Sequence	Title of Active Screen	Result
Start | Programs | AspenTech | Aspen Engineering Suite | Aspen OnLine <version> | Project Manager	Aspen OnLine <version> Project Manager	Aspen OnLine <version> Project Manager window
Type the server computer name (for example, aeschem2) in the **Computer** field and then press **Enter**		**Create** and **Register** buttons are enabled
Click **Create**	Create project on aeschem2	Create project on aeschem2 dialog box appears, where *aeschem2* is the server computer name used. By default, **Create a blank project** option is selected.
Type new project name: Heatx		Heatx is the project name
Specify new project location by clicking corresponding **Browse** button or by typing: d:\apowork		The new location is a folder where the new project will be created. Do not use a backslash (\ ) at the end of the name.
Click **Create**	Aspen OnLine <version> Project Manager	The new Aspen OnLine project has been created.
Click **Close** to close Aspen OnLine Project Manager window		Aspen OnLine project Manager window is closed

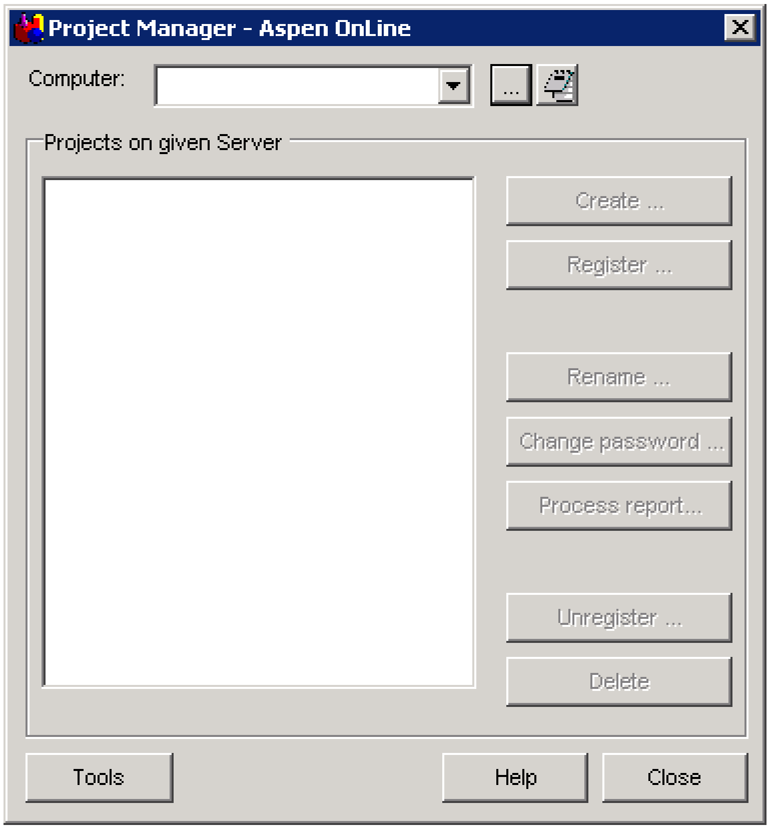
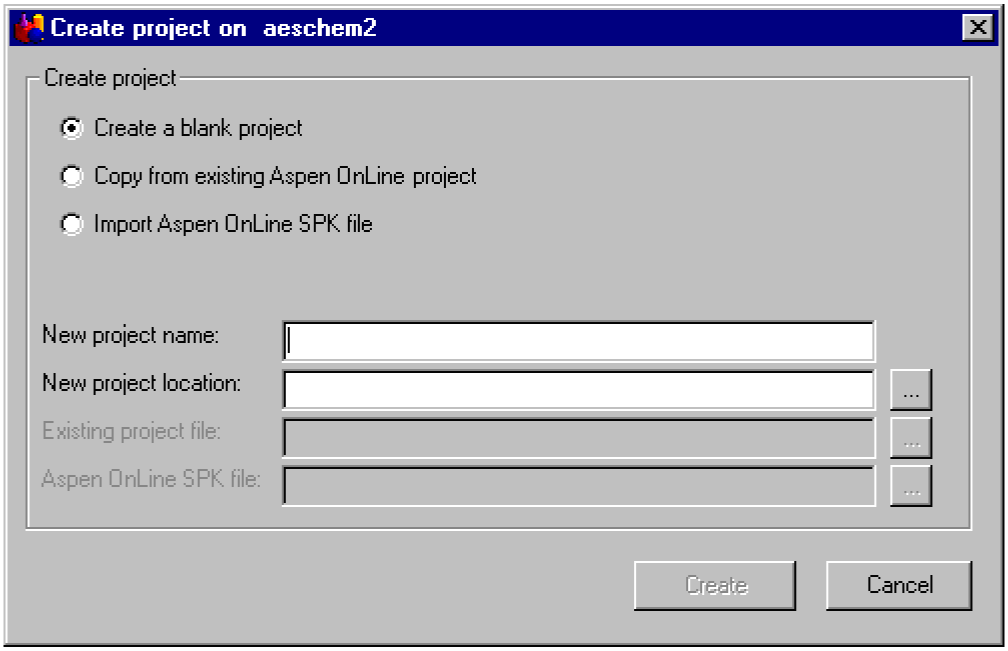


Figure 5: Aspen OnLine Project Manager window



● Create a blank project

○ Copy from existing Aspen OnLine project

○ Import Aspen OnLine SPK file

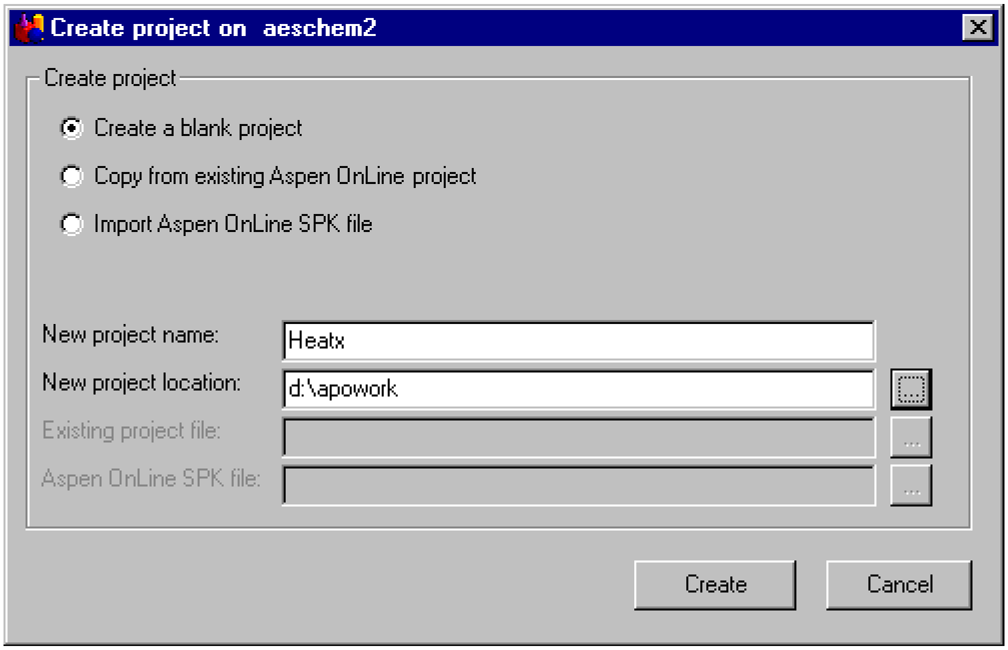
New project name:

New project location:

Existing project file:

Aspen OnLine SPK file:

Figure 6: Blank Project Creation Form



Create project on aeschem2

Create project

● Create a blank project

○ Copy from existing Aspen OnLine project

○ Import Aspen OnLine SPK file

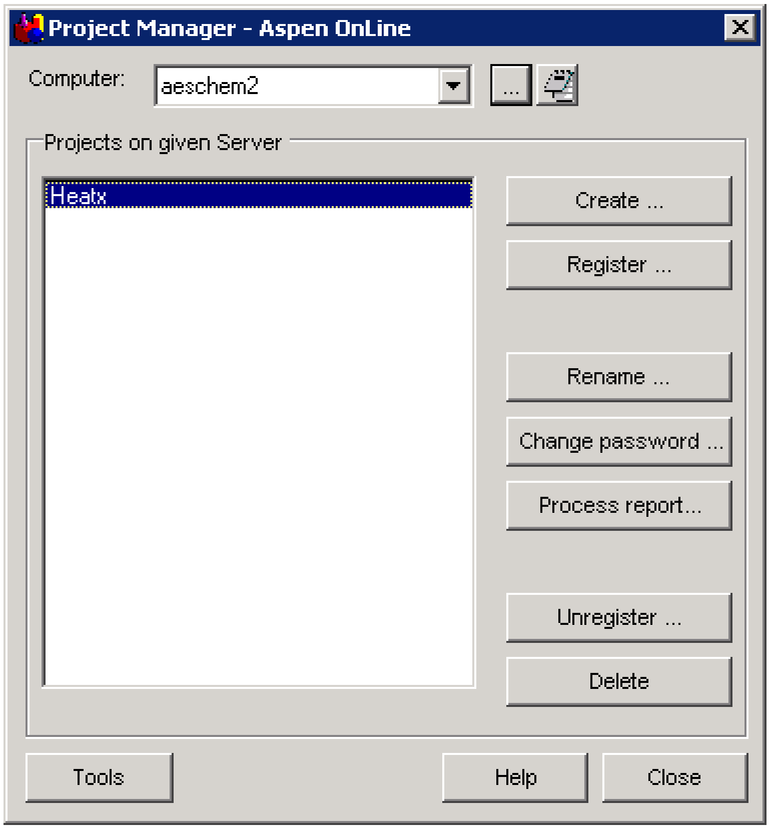
New project name: Heatx

New project location: d:\apowork

Existing project file:

Aspen OnLine SPK file:

Figure 7: Completed Project Creation Form



Project Manager - Aspen OnLine

Computer: aeschem2

Projects on given Server

Heatx

Figure 8: Aspen OnLine Project Manager screen with new project listed

Based on the information provided during the project creation step, Aspen OnLine creates the following directory structure and creates a blank database. The Engine Configuration database is actually a set of structured files and is identified by the project name. The GUI Configuration database is a file named Heatx.GDB. These files are placed in the Engine and GUI folders respectively.

```
Directory Structure________________   Files____________________
 [D:]___
       |_apowork
              |__Heatx                Config.mdb
                     |_Hist
                     |_OffLine
                     |_OnLine
```

At this point, all three folders within the Heatx directory are empty. Config.mdb is a blank database that will be used to hold all project configuration information. Project specifications needed by Aspen OnLine engine program and end-user GUI configuration are stored in this database. Furthermore, all clients of this project share this database during run-time.

Copy the heatxn1.bkp and heatxn2.bkp file from the Documentation directory to the OffLine sub-folder in the HeatX directory; heatxn1.bkp will be used as the monitoring model and heatxn2.bkp will be used as the What-if model.

When the new project is created, the on-line project structure is created. Configuration information must be provided to develop the project into a full-blown on-line application.

4 Configure the Engine Data

Configuration Steps

Configuring the Engine involves defining the process models and the plant data to be used, linking of model input and output variables to application tag names, and providing information for the analysis and validation of data, and for any other calculations that are to be performed by the on-line application. Plant tags whose values are input to the model are used in Aspen OnLine with the same names as specified in the plant IMS/DCS. Model output variables must be associated with tags whose names are specified by the user.

Configuring the engine data consists of three steps. The first step involves identifying plant tag names and generating tag names for the variables that represent model input and output. The next step involves identifying and linking the Aspen Plus model variables to the tag names. The last step involves providing all the additional data validation and analysis information as well as application control information.

Model Structure and Solution Strategy

Some understanding of the model structure and solution strategy is needed before we can link tag names to model variables. The model consists of three blocks: the preheater, a steam valve, and a duplicator block, which is merely a modeling artifact that is used to specify the oil temperature at the outlet of the preheater. Design Spec 1 is used to vary the steam flow so that the heat exchanger duty matches the change in enthalpy of the oil. Design Spec 2 varies the oil-side fouling factor until the calculated exchanger area matches the specified area.

Most of the tag-to-model variable links are conventional. Two links need further explanation. The plant exit oil temperature tag is linked to the dummy duplicator inlet stream, XS1. This is because in this model, Aspen Plus will not permit the direct specification of the oil outlet temperature. The calculated fouling factor is obtained as output from Design Spec 2, and must be linked to the fouling factor tag.

Summary of Model Inputs and Outputs

The model input and output variables are described in Table 1. This tutorial illustrates the use of plant tag values and an internal application tag value (operator what-if input value) as inputs to process models and the use of internal application tags to display and manipulate model results. When plant tag values are used as inputs to the model, the tag names used in Aspen OnLine must be identical to the names used in IP.21. Internal application tags can have any user-specified names. Both models in this tutorial use the same sources of plant values. In addition, the What-if model also has a tag for operator entry of the inlet oil temperature. When an on-line project uses multiple models, it is recommended that internal application tags associated with model output values be unique to each model. In this tutorial, the internal application tags associated with the What-if model are identified with the prefix HXWI while the output values from the monitor model are identified with the prefix HX.

There are three Aspen OnLine tag types shown in this table. The DCS tags refer to the plant tags in IP.21 whose values are used as inputs to the on-line application. Local GUI (or local) tags are internal application tags that are used internally in the on-line application to manage data transfers and present results in the GUI; the values of these tags can be different for different users depending upon the values provided as inputs to model calculations. Aspen OnLine can be used to create mathematical functions of tag values and compute the function values. The computed function values are stored in Formula tags.

Model Input/ Output	Tag Name	Description	Tag Type
Input	HX-F-101	Oil Flowrate	DCS
Input	HX-T-101	Oil Inlet Temperature	DCS
Input	HX-T-102	Oil Outlet Temperature	DCS
Input	HX-P-401	Steam Header Pressure	DCS
Input	HX-P-301	Exchanger Steam Pressure In	DCS
Monitor Outputs			
Output	HX-UACT	Actual Heat Transfer Coefficient	Local GUI
Output	HX-UCLEAN	Clean Exchanger U	Local GUI
Output	HX-UEFF	U Efficiency	Formula
Output	HX-FOULFCTR	Oil Side Fouling Factor	Local GUI
Output	HX-T-301-CALC	Shell Side Temperature	Local GUI
Output	HX-F-401-CALC	Calculated Steam Flow	Local GUI
What If Input			
Input	HXWI-T-101-INPUT	WIF Oil Inlet Temperature Entry	Local GUI
What If Outputs			
Output	HXWI-UACT	WIF Actual Heat Transfer Coefficient	Local GUI
Output	HXWI-UCLEAN	WIF Clean Exchanger U	Local GUI
Output	HXWI-UEFF	WIF U Efficiency	Formula
Output	HXWI-FOULFCTR	WIF Oil Side Fouling Factor	Local GUI
Output	HXWI-T-301-CALC	WIF Shell Side Temperature	Local GUI
Output	HXWI-F-401-CALC	WIF Calculated Steam Flow	Local GUI

Table 1: Model Input and Output Variables

Starting Engine Configuration

The blank database that has been created for the Heatx project must now be provided enough information to develop it into a useful on-line application.

To start project configuration:

1 Click the Windows **Start** button, then **Programs | AspenTech | Aspen Engineering Suite | Aspen OnLine <version> | Client GUI**.

  The Aspen OnLine main window and Aspen OnLine Startup dialog box are displayed. Select the appropriate Server name and Project name. Project password is blank by default. (Use the Aspen OnLine Project Manager program to set or change the project password.)

2 Click **OK** to close the **Startup** dialog box.

  The Aspen OnLine Control Panel appears. The Control Panel is used at run-time and can be closed during project configuration.

3 Click **Data Browser** command on the **Data** menu (or click **Data browser** button on the toolbar) to bring up the **Aspen OnLine Data Browser**.

The Data Browser is used for project configuration and you can open several data browsers at the same time.

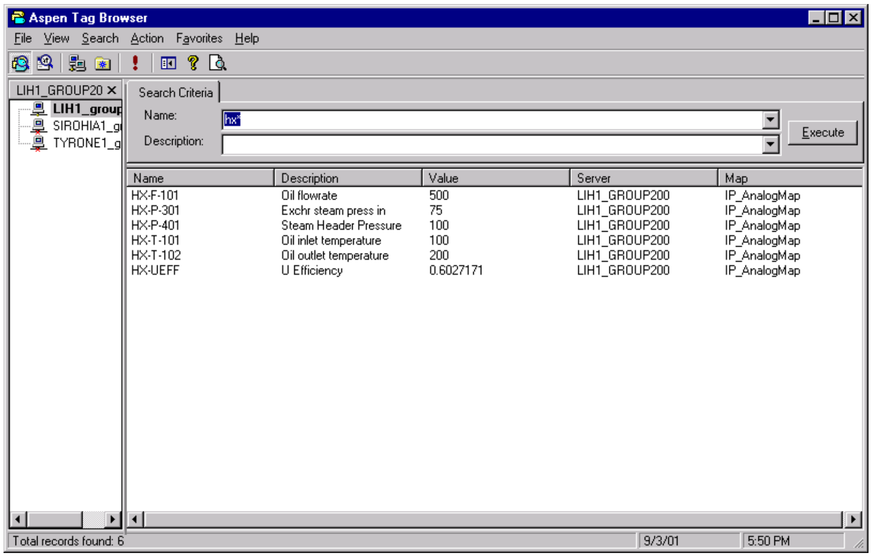
Selecting Plant Tags in Tag Browser

Open a Data browser and navigate to the **Tags | Grid View | Tag Definition** sheet. Note that there are some tags defined already. These are signal tags and are used during run-time. Therefore, they can be ignored during project configuration.

In this tutorial, the plant tags for use in the heat exchanger project are dragged and dropped from IP.21 into the **Tag Definition** sheet of the Engine Configuration interface using the Tag Browser component of Aspen Process Explorer. This is only available if Aspen Process Explorer is installed on the Aspen OnLine server PC. If the DCS (plant) tags needed for this tutorial are not created in IP.21 or if Process Explorer is not installed in this PC, these tags cannot be dragged and dropped into the Tag Definition form. In these cases, enter the tags manually as described in the *Define Plant and Internal Application Tags Manually* section, and specify them as *DCS* tags.

Define Plant Variable Tags Using the Tag Browser

Button Sequence	Title of Active Screen	Result
Start | Programs | AspenTech | Aspen Engineering Suite | Aspen OnLine <version> | Client GUI if Client GUI has not already started	Aspen OnLine Startup dialog box	
Select server name from the list. **Select project name from the list.** **Click OK**	Aspen OnLine – Heatx on aeschem2	Aspen OnLine main window with Control Panel becomes active. *Aeschem2* represents the server machine name.
Click **Close** on the Control Panel		Control Panel closes
Click **Data Browser** button on the toolbar	Data Browser	A Data Browser is displayed
In the **Data Browser**, expand **Tags** node and then, under **Tags** node, click **Grid View** node	Tags Grid View – Data Browser	**Tag Definition** sheet is displayed
Click **Tag Browser**	Aspen Tag Browser	Ready to search for tags
Type **HX*** in **Tag Name** box and click **Execute**		All heat exchanger tags created in IP.21 for this project are displayed.
Select the first five tags. (Click top variable then shift-click fifth tag.)		Five tags highlighted
Drag and drop five selected tags onto **Tag Definition** sheet	Select CIM-IO Device	Transfer inhibited and data entry screen appears
For **CIMIO Device** enter IOSETCIM200 For **CIMIO Source** enter DVBL Click **OK**	Aspen Tag Browser	Variable tags still highlighted
Drag and drop five selected tags onto **Tag Definition** sheet	Tag Definition Form	Five tags now displayed in Tag Definition sheet. Note that Aspen OnLine now provides a built-in engineering unit system. If a unit string used in IMS (e.g., IP.21) does not match in the Aspen OnLine unit system, then a dialog box will popup and request you to manually find a match. Create a new unit type and units if necessary.
Close **Tag Browser**	Tags Grid View – Data Browser	



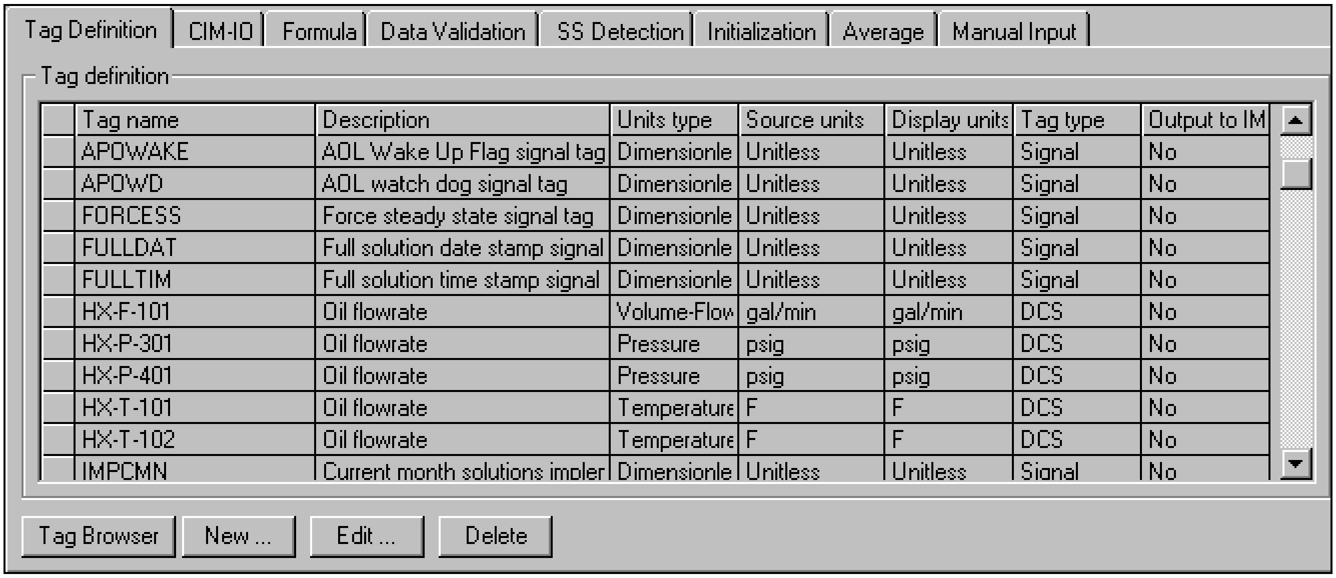
Name: hx*

Description:

Name	Description	Value	Server	Map
HX-F-101	Oil flowrate	500	LIH1_GROUP200	IP_AnalogMap
HX-P-301	Exchr steam press in	75	LIH1_GROUP200	IP_AnalogMap
HX-P-401	Steam Header Pressure	100	LIH1_GROUP200	IP_AnalogMap
HX-T-101	Oil inlet temperature	100	LIH1_GROUP200	IP_AnalogMap
HX-T-102	Oil outlet temperature	200	LIH1_GROUP200	IP_AnalogMap
HX-UEFF	U Efficiency	0.6027171	LIH1_GROUP200	IP_AnalogMap

Total records found: 6 | 9/3/01 | 5:50 PM

Figure 9: Aspen Tag Browser after finding heat exchanger variable tags in IP.21



Tag name	Description	Units type	Source units	Display units	Tag type	Output to IM
APOWAKE	AOL Wake Up Flag signal tag	Dimensionle	Unitless	Unitless	Signal	No
APOWD	AOL watch dog signal tag	Dimensionle	Unitless	Unitless	Signal	No
FORCESS	Force steady state signal tag	Dimensionle	Unitless	Unitless	Signal	No
FULLDAT	Full solution date stamp signal	Dimensionle	Unitless	Unitless	Signal	No
FULLTIM	Full solution time stamp signal	Dimensionle	Unitless	Unitless	Signal	No
HX-F-101	Oil flowrate	Volume-Flow	gal/min	gal/min	DCS	No
HX-P-301	Oil flowrate	Pressure	psig	psig	DCS	No
HX-P-401	Oil flowrate	Pressure	psig	psig	DCS	No
HX-T-101	Oil flowrate	Temperature	F	F	DCS	No
HX-T-102	Oil flowrate	Temperature	F	F	DCS	No
IMPCMN	Current month solutions impler	Dimensionle	Unitless	Unitless	Signal	No

Figure 10: Tag Definition sheet after plant tags transferred

Define Plant and Internal Application Tags Manually

The user must manually enter all non-plant, internal application tags in the **Tag Definition** sheet. Plant tags must also be entered manually when a DCS or a non-AspenTech IMS is used, Process Explorer is not available, or when this tutorial is being used without connecting to a plant data server. The following procedure used to enter internal application tags is also applicable to plant tags. Plant variables are designated *DCS*, whereas the internal application variables are designated *Manual, Formula, Local GUI, Average, SSD* and *Signal*.

Tags associated with on-screen data entry boxes must also be defined. These are designated *Local GUI* variables.

One of the useful features of the Tag Definition display is the ability to click a column heading to instantly sort the table alphanumerically. Columns can also be resized by using standard Windows techniques.

Use the **New** button to insert a new tag name into the **Tag Definition** sheet. Enter a full definition of the tag that is being added, including its units, tag type and whether this tag value is to be sent back to and stored in the plant IMS. The default tag type is *Local GUI* and by default no tag values will be stored in the IMS. In this tutorial, only the value of the tag HX-UEFF associated with the calculated heat transfer efficiency will be sent as output to IMS. The tags to be created and the information to be entered for each of these tags are shown in Figure 11 (in the following section of this chapter).

Define Plant and Internal Application Tags Manually

Button Sequence	Title of Active Screen	Result
Open a Data Browser in the Aspen OnLine Client GUI and navigate to the **Tags | Grid View | Tag Definition** sheet.	Tags Grid View – Data Browser	
Click **New**	Add New Tag	
Specify **Tag name, Description, Units type, Source units, Display units,** and Tag type and select required option for Output to IMS. Click Add Next Tag.		User-specified information entered and display reset for new entry. **Data type** should be **Float**.
Continue until all tags are entered as shown in Figure 11. Click **Quit**.	Tags Grid View – Data Browser	All tag definitions entered.

Define the Heat Transfer Efficiency Tag and Specify its Write-back to IMS

The heat transfer efficiency value that is calculated by Aspen OnLine in the Monitor module of this example will be used as the indicator of the heat exchanger performance status. This value will be stored in the IMS for trending and further analysis to determine when the heat exchanger should be cleaned to maintain its efficiency at optimal levels.

Aspen OnLine provides the ability to define a value to be calculated from a mathematical function of any combination of project tags and store the calculated value in a *Formula* tag. Any valid Excel expression may be used.

This provides Aspen OnLine with a very powerful capability. In the case of the heat exchanger model, the heat transfer efficiency is determined by the ratio of UACT to UCLEAN. This requires that the UEFF be defined as a *Formula* tag.

The value of any internal application tag (any tag other than a *DCS* tag) can be sent back to IMS and stored for further analysis. The **Output to IMS** attribute of an internal application tag should be set to *Yes* in the **Tag Definition** sheet to enable its value to be sent back and stored in the plant IMS. In this tutorial, the calculated values of the HX-UEFF tag will be stored in the IMS. To accomplish this, a tag should be created in the IMS (IP.21 in the case of this tutorial) with an identical name, that is, HX-UEFF and an initial value should be given to it. Thus, a tag named HX-UEFF is created in the IP.21 server in LIH1 and an initial value of 0.70 is given to this tag to denote 70% efficiency.

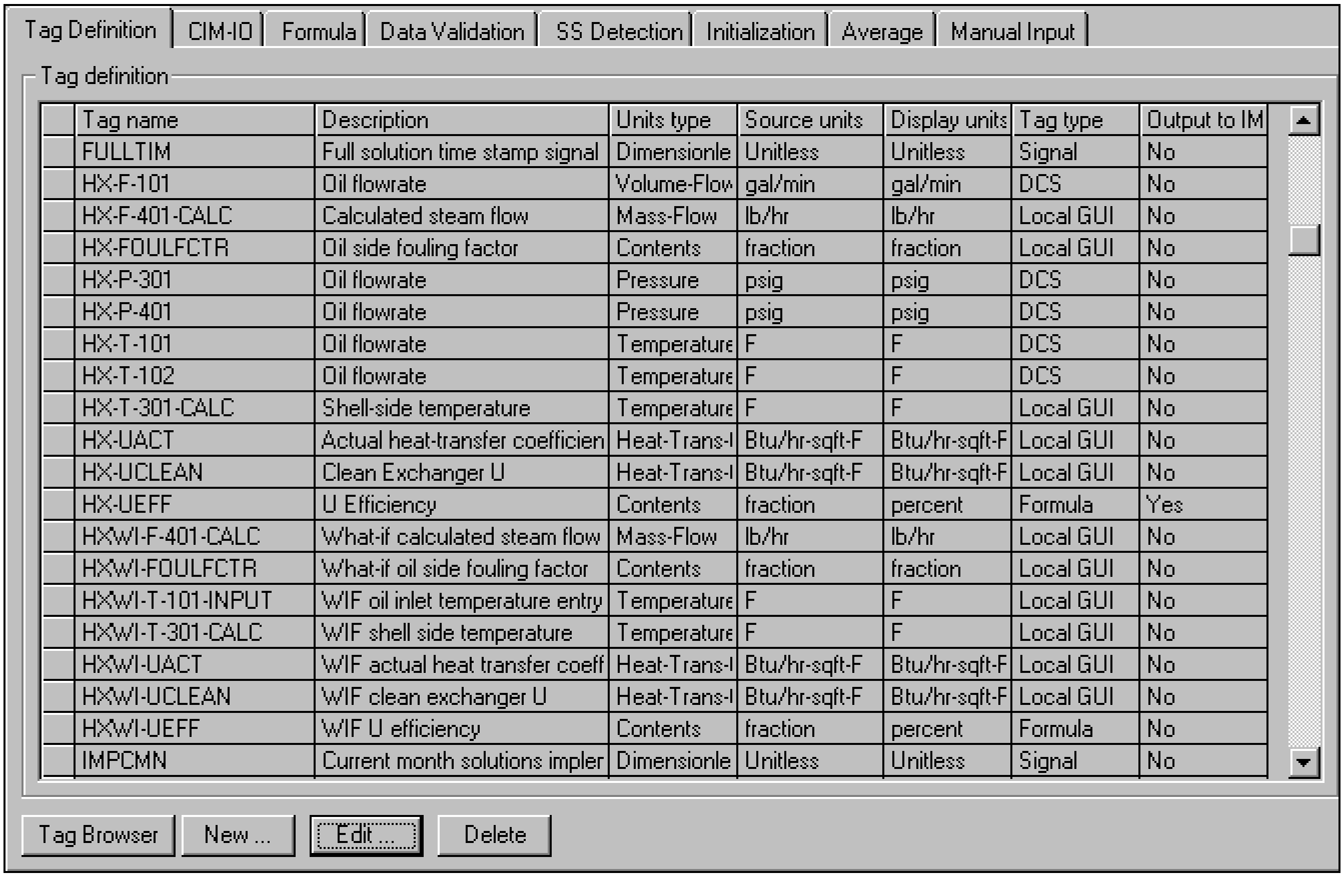
An Aspen OnLine tag value is sent to the IMS only after the successful completion of *scheduled* or automatic, unattended model calculations. The value of a tag that is specified as a *write-back* tag will not be stored in the IMS after on-demand calculations. Unless information is provided in the **Models | Scheduling** sheet for automated model execution, the write-back action will not be implemented.

Define the Write-back Tag

Button Sequence	Title of Active Screen	Result
Select **Tags** | Grid View | Tag Definition sheet.	Tags Grid View – Data Browser	**Tag Definition** sheet is displayed
Click **New**.	Add New Tag	Tag name entry dialog box displayed
Enter *HX-UEFF* for the **Tag name**, *Heat Transfer Coefficient Efficiency* for the **Description**, *Contents* for **Units type**, *Fraction* for the **Source units**, and *Percent* for the **Display units.**		The new exchanger heat transfer efficiency value defined.
For the **Tag type** select *Formula***.**		Establishes **HX-UEFF** as a computed variable.
For **Output to IMS** select *Yes***.**		Establishes HX-UEFF as a *write-back* tag whose values will be stored in the IMS.
Click **Add Next Tag**.		
Click **Quit**.	Tags Grid View – Data Browser	**Tag Definition** sheet is displayed
Select the **Formula** tab.	Tags Grid View – Data Browser	**HX-UEFF** shown in the **Tag name** column
Follow the syntax shown in the example and type **[HX-UACT]/[HX-UCLEAN]** under **Formula.**		Formula completed. Typing the left square bracket produces a drop-down list of all project tags.
Repeat entire sequence for the What-if model.	**Tags Grid View – Data Browser**	HXWI-UEFF defined

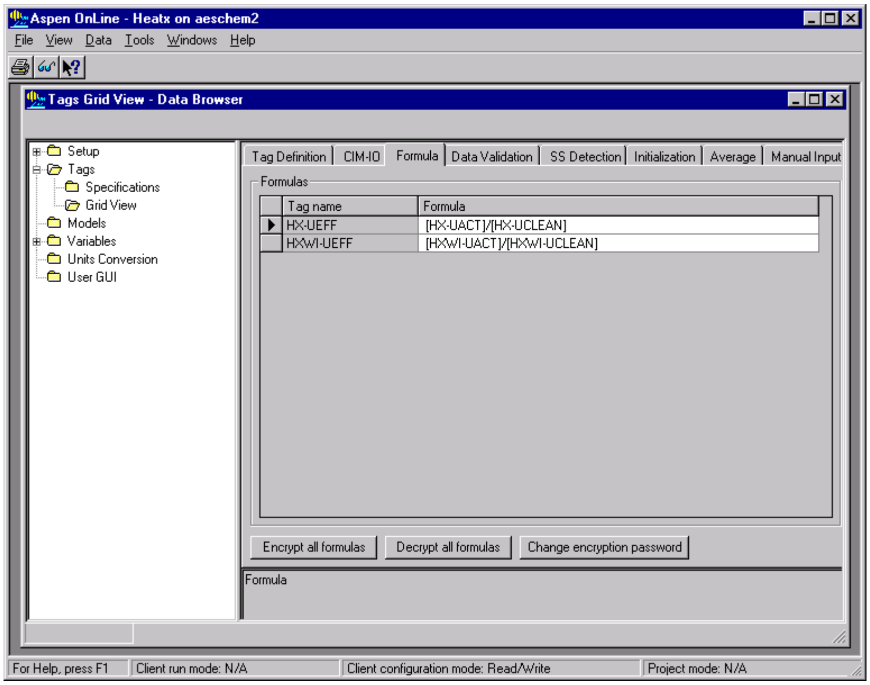
Figure 11 shows the Tag Definition sheet after all tags for both the monitoring and the What-if modules have been entered.

Figure 12 shows the two formulas for the calculation of the heat transfer efficiency value, UEFF. One formula is for the Monitor module and the other is for the What-if module.



Tag name	Description	Units type	Source units	Display units	Tag type	Output to IM
FULLTIM	Full solution time stamp signal	Dimensionle	Unitless	Unitless	Signal	No
HX-F-101	Oil flowrate	Volume-Flow	gal/min	gal/min	DCS	No
HX-F-401-CALC	Calculated steam flow	Mass-Flow	lb/hr	lb/hr	Local GUI	No
HX-FOULFCTR	Oil side fouling factor	Contents	fraction	fraction	Local GUI	No
HX-P-301	Oil flowrate	Pressure	psig	psig	DCS	No
HX-P-401	Oil flowrate	Pressure	psig	psig	DCS	No
HX-T-101	Oil flowrate	Temperature	F	F	DCS	No
HX-T-102	Oil flowrate	Temperature	F	F	DCS	No
HX-T-301-CALC	Shell-side temperature	Temperature	F	F	Local GUI	No
HX-UACT	Actual heat-transfer coefficien	Heat-Trans-I	Btu/hr-sqft-F	Btu/hr-sqft-F	Local GUI	No
HX-UCLEAN	Clean Exchanger U	Heat-Trans-I	Btu/hr-sqft-F	Btu/hr-sqft-F	Local GUI	No
HX-UEFF	U Efficiency	Contents	fraction	percent	Formula	Yes
HXWI-F-401-CALC	What-if calculated steam flow	Mass-Flow	lb/hr	lb/hr	Local GUI	No
HXWI-FOULFCTR	What-if oil side fouling factor	Contents	fraction	fraction	Local GUI	No
HXWI-T-101-INPUT	WIF oil inlet temperature entry	Temperature	F	F	Local GUI	No
HXWI-T-301-CALC	WIF shell side temperature	Temperature	F	F	Local GUI	No
HXWI-UACT	WIF actual heat transfer coeff	Heat-Trans-I	Btu/hr-sqft-F	Btu/hr-sqft-F	Local GUI	No
HXWI-UCLEAN	WIF clean exchanger U	Heat-Trans-I	Btu/hr-sqft-F	Btu/hr-sqft-F	Local GUI	No
HXWI-UEFF	WIF U efficiency	Contents	fraction	percent	Formula	No
IMPCMN	Current month solutions impler	Dimensionle	Unitless	Unitless	Signal	No

Figure 11: Tag Definition sheet after all tags entered



	Tag name	Formula
▶	HX-UEFF	[HX-UACT]/[HX-UCLEAN]
	HXWI-UEFF	[HXWI-UACT]/[HXWI-UCLEAN]

Figure 12: Formula sheet with UEFF calculation shown

Connect the heatxn1 and heatxn2 Models

A model is connected to Aspen OnLine with a simple sequence. More than one model can be connected by using this sequence repeatedly.

Connect the heatxn1 and heatxn2 Models

Button Sequence	Title of Active Screen	Result
Select **Models** | Model Selector sheet.	Models – Data Browser	Models | Model Selector sheet is displayed.
Click **New**.	Open	File-open dialog box displayed
Browse into **OffLine** folder		Found at D:\apowork\Heatx\OffLine\heatxn1.bkp
Click **Open**.	Models – Data Browser	heatxn1.bkp appears on the **Model Selector** sheet
Expand **Models** node in the tree view on the left and then click **heatxn1.bkp** node	Models heatxn1.bkp – Data Browser	Models | heatxn1.bkp | Specifications sheet is displayed.
Click **Offline to online**.	Offline to online	**Offline to online** dialog box is displayed
Click **Start**.		Variable list for this model is generated and **Offline to online** dialog box is closed.
Select the **Data validation required** checkbox. Leave the Steady-state detection required checkbox cleared.	Models heatxn1.bkp – Data Browser	Aspen OnLine checks to see that the plant data used as inputs to the application are within specified ranges. Inputs for the data validation and steady state detection will be specified later.
Repeat this entire sequence for the What-if model.	**Models – Data Browser**	**heatxn2** connected

Link Model Variables to Tags

Use the list of tag names and model variables given in Table 2 in the following manner. A list of all the project tag names appears at the left of the **Models |** *model name* | **Variable-Tag Mapping** sheet, and the model variable tree is displayed on the right. The tag that is to be associated with a model variable should be identified before searching the model variable tree for the variable name. Be sure not to confuse model input and output variables in the tree. Once the model variable name has been exposed in the variable tree, a link with the appropriate project tag is established by clicking and dragging the tag name onto the variable name and dropping it.

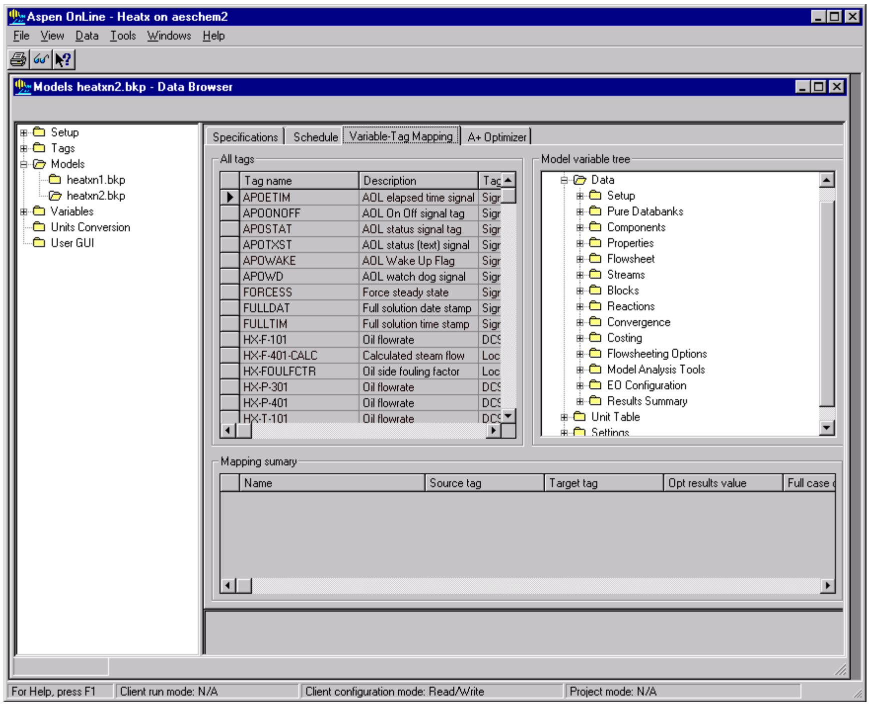
Model	Tag Name	Model Variable Name
HEATXN1	HX-UCLEAN	ROOT.DATA.BLOCKS.PREHEATER.OUTPUT.HX_UAVC
HEATXN1	HX-UACT	ROOT.DATA.BLOCKS.PREHEATER.OUTPUT.HX_UAVD
HEATXN1	HX-P-301	ROOT.DATA.BLOCKS.VALVE.INPUT.P_OUT
HEATXN1	HX-FOULFCTR	ROOT.DATA.CONVERGENCE.CONVERGENCE.$OLVER02.OUTPUT.VAR_VAL.1
HEATXN1	HX-T-301-CALC	ROOT.DATA.STREAMS.CNDNSATE.OUTPUT.TEMP_OUT.MIXED
HEATXN1	HX-T-101	ROOT.DATA.STREAMS.COLDOIL.INPUT.TEMP.MIXED
HEATXN1	HX-F-101	ROOT.DATA.STREAMS.COLDOIL.INPUT.TOTFLOW.MIXED
HEATXN1	HX-P-401	ROOT.DATA.STREAMS.STEAM.INPUT.PRES.MIXED
HEATXN1	HX-F-401-CALC	ROOT.DATA.STREAMS.STEAM.OUTPUT.MASSFLMX.MIXED
HEATXN1	HX-T-102	ROOT.DATA.STREAMS.XS1.INPUT.TEMP.MIXED
HEATXN2	HXWI-UCLEAN	ROOT.DATA.BLOCKS.PREHEATER.OUTPUT.HX_UAVC
HEATXN2	HXWI-UACT	ROOT.DATA.BLOCKS.PREHEATER.OUTPUT.HX_UAVD
HEATXN2	HX-P-301	ROOT.DATA.BLOCKS.VALVE.INPUT.P_OUT
HEATXN2	HXWI-FOULFCTR	ROOT.DATA.CONVERGENCE.CONVERGENCE.$OLVER02.OUTPUT.VAR_VAL.1
HEATXN2	HXWI-T-301-CALC	ROOT.DATA.STREAMS.CNDNSATE.OUTPUT.TEMP_OUT.MIXED
HEATXN2	HX-T-101	ROOT.DATA.STREAMS.COLDOIL.INPUT.TEMP.MIXED
HEATXN2	HX-F-101	ROOT.DATA.STREAMS.COLDOIL.INPUT.TOTFLOW.MIXED
HEATXN2	HX-P-401	ROOT.DATA.STREAMS.STEAM.INPUT.PRES.MIXED
HEATXN2	HXWI-F-401-CALC	ROOT.DATA.STREAMS.STEAM.OUTPUT.MASSFLMX.MIXED
HEATXN2	HX-T-102	ROOT.DATA.STREAMS.XS1.INPUT.TEMP.MIXED

Table 2 Tag Names and Model Variable Names

Linking Model Variables to Tags

Button Sequence	Title of Active Screen	Result
Open the **Models | heatxn1.bkp | Variable-Tag Mapping** sheet in the Data Browser.	Models heatxn1.bkp – Data Browser	
To link tag HX-UCLEAN to the clean exchanger U, first locate HX-UCLEAN in the **All tags** frame. Then click, in turn: *Root, Data, Blocks, PREHEATER, Output* in the **Model variable tree**.		Tree expands.
Search tree for HX-UAVC.		Preheater model clean heat transfer coefficient.
Click and hold the mouse button on HX-UCLEAN in the **All tags** frame. Drag and drop it onto HX_UAVC label in the **Model variable tree**.	Tag links for model variable	Model variable information is displayed. Ensure that the units type of the variable and the units type of the linked tag match. Otherwise, units conversion will fail.
Select the **Target** option.		**Average input value over** field dims. If this had been an input to a model variable, filter time in minutes could have been entered.
Click **OK.**	Models heatxn1.bkp – Data Browser	HX-UCLEAN label attached to tree. Both model variable and tag name displayed in **Mapping summary** display at the bottom of this sheet.
Repeat for all heatxn1 model variables.		All heatxn1 links complete.
Repeat for all heatxn2 model variables.		All heatxn2 links complete.

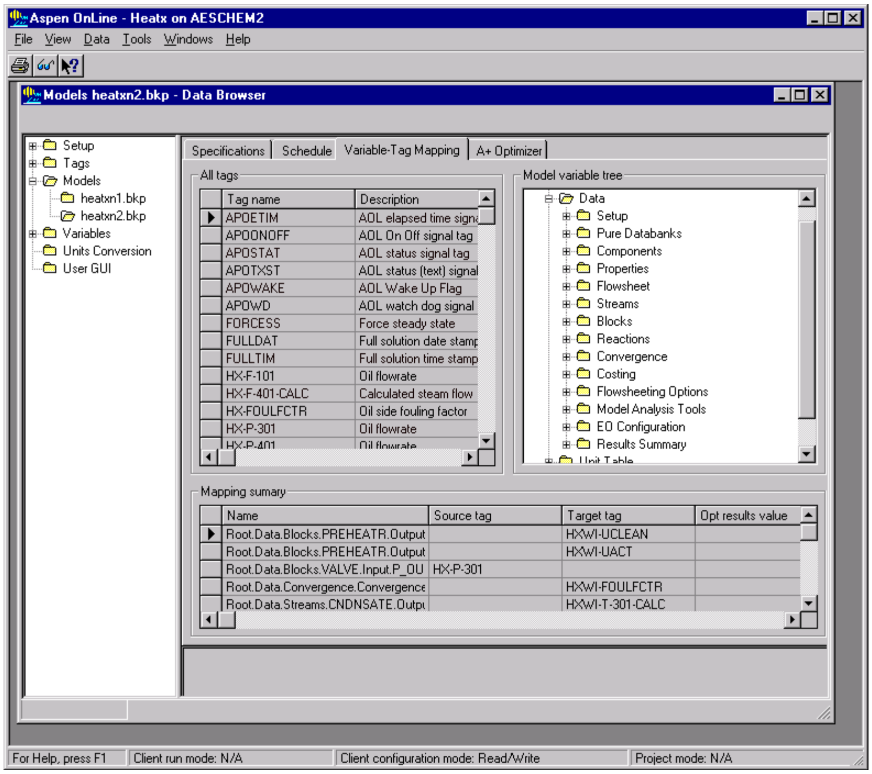
The **Variable-Tag Mapping** sheet before mapping is shown in Figure 13. In Figure 14 the **Variable-Tag Mapping** sheet is shown with all linkages established.



Tag name	Description	Tag
APOETIM	AOL elapsed time signal	Sigr
APOONOFF	AOL On Off signal tag	Sigr
APOSTAT	AOL status signal tag	Sigr
APOTXST	AOL status (text) signal	Sigr
APOWAKE	AOL Wake Up Flag	Sigr
APOWD	AOL watch dog signal	Sigr
FORCESS	Force steady state	Sigr
FULLDAT	Full solution date stamp	Sigr
FULLTIM	Full solution time stamp	Sigr
HX-F-101	Oil flowrate	DCS
HX-F-401-CALC	Calculated steam flow	Loc
HX-FOULFCTR	Oil side fouling factor	Loc
HX-P-301	Oil flowrate	DCS
HX-P-401	Oil flowrate	DCS
HX-T-101	Oil flowrate	DCS

Name	Source tag	Target tag	Opt results value	Full case

Figure 13: Variable-Tag Mapping sheet before mapping is performed



Tag name	Description
APOETIM	AOL elapsed time signa
APOONOFF	AOL On Off signal tag
APOSTAT	AOL status signal tag
APOTXST	AOL status (text) signal
APOWAKE	AOL Wake Up Flag
APOWD	AOL watch dog signal
FORCESS	Force steady state
FULLDAT	Full solution date stamp
FULLTIM	Full solution time stamp
HX-F-101	Oil flowrate
HX-F-401-CALC	Calculated steam flow
HX-FOULFCTR	Oil side fouling factor
HX-P-301	Oil flowrate
HX-P-401	Oil flowrate

Name	Source tag	Target tag	Opt results value
Root.Data.Blocks.PREHEATR.Output		HXWI-UCLEAN	
Root.Data.Blocks.PREHEATR.Output		HXWI-UACT	
Root.Data.Blocks.VALVE.Input.P_OU	HX-P-301		
Root.Data.Convergence.Convergence		HXWI-FOULFCTR	
Root.Data.Streams.CNDNSATE.Outpu		HXWI-T-301-CALC	

Figure 14: Variable-Tag Mapping sheet after mapping is performed

Identifying the Correct Model Variable

After successfully running the Aspen Plus model independent of Aspen OnLine from the Aspen Plus user interface, identify the variables for which inputs will be provided via Aspen OnLine and variables from which results will be obtained and displayed via Aspen OnLine. Locate them and their current values in the various input and results forms of the Aspen Plus user interface.

Aspen OnLine establishes links based on the full Aspen Plus variable name. Aspen Plus organizes its variable names in a tree structure that is accessible through the **Variable Explorer** either from the **Tools** menu or from its toolbar icon. Aspen OnLine uses the same tree structure at configuration time to establish on-line links.

To understand the variable structure of a given model, open the Variable Explorer and locate each variable that is to be connected. If you are unsure if you have located the correct variable, check the value displayed by the Variable Explorer with the value given in the input or results form of the Aspen Plus user interface to confirm your selection.

An alternative method for identifying the correct variable name is to locate it on the Aspen Plus interface, copy the variable and then paste-link it into an Excel spreadsheet. The formula line will give the complete name of the variable.

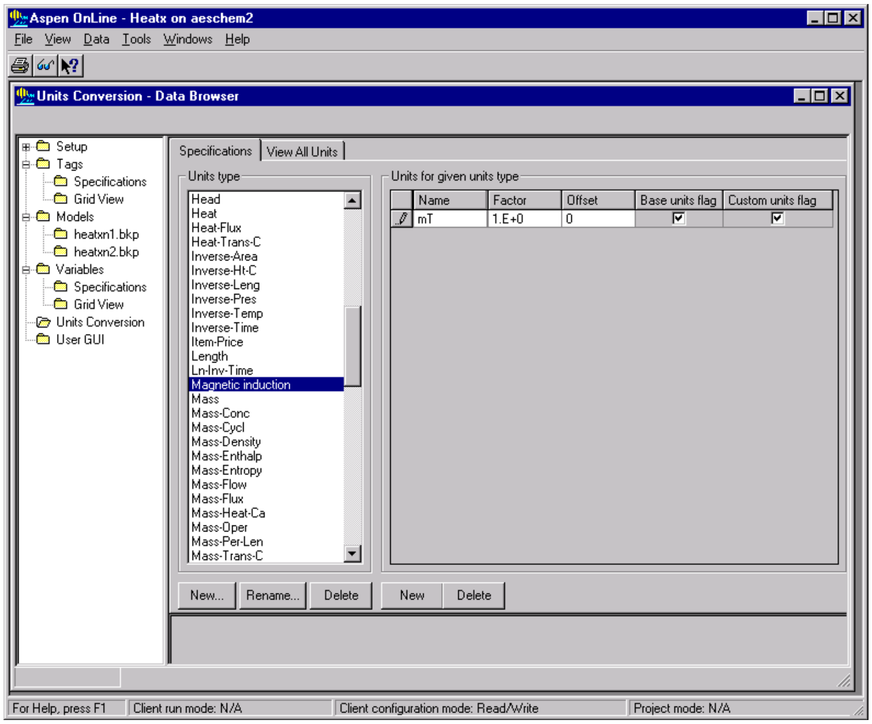
Define Unit Conversion Factors

Plant tag units, model variable units, and display units used in Aspen OnLine project screens for a particular variable may all differ. However, source units and display units of a tag and corresponding linked model variables must share the same units type in order for unit conversion to work properly at run-time. Aspen OnLine provides a built-in unit system. Custom units types and units can be added to the system for specific projects. Custom units types and units can also be added during variable-tag mapping, or using the **Units Conversion** | **Specifications** sheet. Although Aspen OnLine's built-in units system is sufficient to cover all units needed, the following steps show how a custom units type and new units can be created.

Define Units Conversion Factors

Button Sequence	Title of Active Screen	Result
Open the **Units Conversion | Specifications** sheet in the Data Browser.	Units Conversion – Data Browser	Available units types are listed on the left and corresponding units for a selected units type is displayed on the right.
Click the **New** button on the left.	Create Units Type	Create Units Type is displayed
Enter *Magnetic induction* and then click **OK**.	Units Conversion – Data Browser	**Create Units Type** is closed and the new units type is added to the **Units type** list and is selected. A new unit is created for this new type.
Rename *New units* in the grid to *mT.*		Creation of new units type and new units is complete.

Figure 15 shows the newly-created units type and units.



Name	Factor	Offset	Base units flag	Custom units flag
mT	1.E+0	0	☑	☑

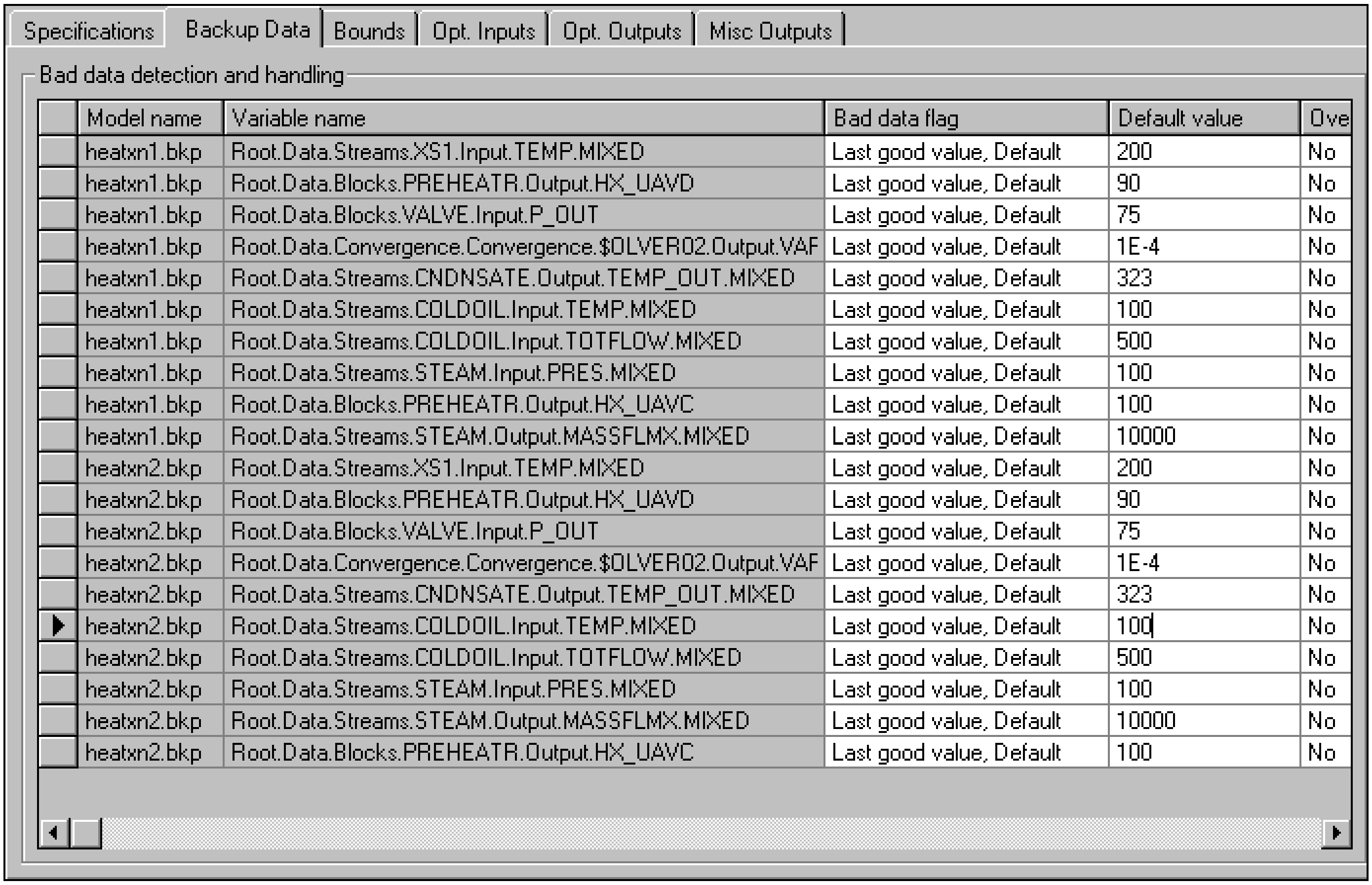
Figure 15: Units Conversion | Specifications sheet

Define Model Variable Properties

Sheets on the **Variables** | **Grid View** form can be used to specify model variable properties. If the **Units type** and **Units** are *Dimensionless* and *Unitless* respectively because the variable did not have units in the Aspen Plus context (such as mass fractions and other composition variables) and the project tag associated with it has units (such as percent for composition values), the desired units type and units can be entered on the **Variables | Grid View | Specifications** sheet. It is very important to make sure that model variables and their linked tags have the same units type. Otherwise, units conversion will fail during run-time.

The **Variables | Grid View | Specifications** sheet also allows specification of variable criticality. If a variable is marked as *critical* and its value is outside the limits specified in the **Tags | Grid View | Data Validation** sheet or if the quality of the data is deemed to be bad, then the model calculations will not be allowed to proceed. Bad data replacement criteria can also be specified for non-critical variables. For instance, bad data may be replaced with either the last good value or a default value entered on the **Variables | Grid View | Backup Data** sheet, or a sequence of the two may be tried, that is, the last good value may be tried first, and if unsatisfactory, the default value may be used.

Refer to Figure 16 for default values.



Model name	Variable name	Bad data flag	Default value	Ove
heatxn1.bkp	Root.Data.Streams.XS1.Input.TEMP.MIXED	Last good value, Default	200	No
heatxn1.bkp	Root.Data.Blocks.PREHEATR.Output.HX_UAVD	Last good value, Default	90	No
heatxn1.bkp	Root.Data.Blocks.VALVE.Input.P_OUT	Last good value, Default	75	No
heatxn1.bkp	Root.Data.Convergence.Convergence.$OLVER02.Output.VAF	Last good value, Default	1E-4	No
heatxn1.bkp	Root.Data.Streams.CNDNSATE.Output.TEMP_OUT.MIXED	Last good value, Default	323	No
heatxn1.bkp	Root.Data.Streams.COLDOIL.Input.TEMP.MIXED	Last good value, Default	100	No
heatxn1.bkp	Root.Data.Streams.COLDOIL.Input.TOTFLOW.MIXED	Last good value, Default	500	No
heatxn1.bkp	Root.Data.Streams.STEAM.Input.PRES.MIXED	Last good value, Default	100	No
heatxn1.bkp	Root.Data.Blocks.PREHEATR.Output.HX_UAVC	Last good value, Default	100	No
heatxn1.bkp	Root.Data.Streams.STEAM.Output.MASSFLMX.MIXED	Last good value, Default	10000	No
heatxn2.bkp	Root.Data.Streams.XS1.Input.TEMP.MIXED	Last good value, Default	200	No
heatxn2.bkp	Root.Data.Blocks.PREHEATR.Output.HX_UAVD	Last good value, Default	90	No
heatxn2.bkp	Root.Data.Blocks.VALVE.Input.P_OUT	Last good value, Default	75	No
heatxn2.bkp	Root.Data.Convergence.Convergence.$OLVER02.Output.VAF	Last good value, Default	1E-4	No
heatxn2.bkp	Root.Data.Streams.CNDNSATE.Output.TEMP_OUT.MIXED	Last good value, Default	323	No
heatxn2.bkp	Root.Data.Streams.COLDOIL.Input.TEMP.MIXED	Last good value, Default	100	No
heatxn2.bkp	Root.Data.Streams.COLDOIL.Input.TOTFLOW.MIXED	Last good value, Default	500	No
heatxn2.bkp	Root.Data.Streams.STEAM.Input.PRES.MIXED	Last good value, Default	100	No
heatxn2.bkp	Root.Data.Streams.STEAM.Output.MASSFLMX.MIXED	Last good value, Default	10000	No
heatxn2.bkp	Root.Data.Blocks.PREHEATR.Output.HX_UAVC	Last good value, Default	100	No

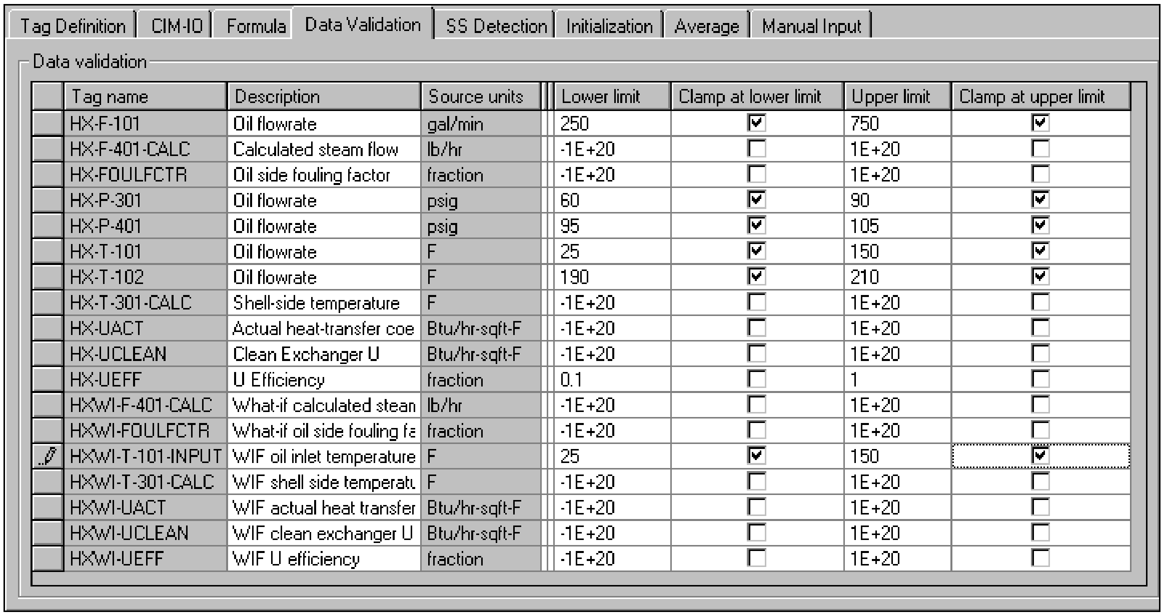
Figure 16: Variables default values

Configure Data Validation

Data validation can be specified using the **Tags | Grid View | Data Validation** sheet. Both input and output variables can be subjected to gross error detection by providing upper and/or lower limit values. If a tag value is outside of its validity limits while the linked model variable is marked as critical, then model calculations will not be allowed to proceed. If the tag is not associated with a critical variable and the clamping option has been selected (by checking **Clamp at lower limit** and/or **Clamp at upper limit**), the value will be *clamped,* replaced by the limit value being exceeded. If the clamping occurred on input values, the model calculations will proceed with the clamped value. If clamping occurred on model output values, the clamped values will be displayed. If a tag has validity limits specified but does not have the clamping option active and is not associated with a critical variable, then calculations will proceed with the out-of-bounds value and only a warning will be recorded in the Event Log. For data validation to be performed with a model execution, the **Data validation required** checkbox should be selected for that model on the **Models |** *model name* **| Specifications** sheet.

A clamped variable can be identified on the GUI by using the conditional display feature to specify that the background color of the display field should change if the data is clamped. This is an example of the Aspen OnLine GUI Conditional Display feature.

Refer to Figure 17 for upper and lower limits on the variables.



Tag name	Description	Source units	Lower limit	Clamp at lower limit	Upper limit	Clamp at upper limit
HX-F-101	Oil flowrate	gal/min	250	☑	750	☑
HX-F-401-CALC	Calculated steam flow	lb/hr	-1E+20	□	1E+20	□
HX-FOULFCTR	Oil side fouling factor	fraction	-1E+20	□	1E+20	□
HX-P-301	Oil flowrate	psig	60	☑	90	☑
HX-P-401	Oil flowrate	psig	95	☑	105	☑
HX-T-101	Oil flowrate	F	25	☑	150	☑
HX-T-102	Oil flowrate	F	190	☑	210	☑
HX-T-301-CALC	Shell-side temperature	F	-1E+20	□	1E+20	□
HX-UACT	Actual heat-transfer coe	Btu/hr-sqft-F	-1E+20	□	1E+20	□
HX-UCLEAN	Clean Exchanger U	Btu/hr-sqft-F	-1E+20	□	1E+20	□
HX-UEFF	U Efficiency	fraction	0.1	□	1	□
HXWI-F-401-CALC	What-if calculated stean	lb/hr	-1E+20	□	1E+20	□
HXWI-FOULFCTR	What-if oil side fouling fa	fraction	-1E+20	□	1E+20	□
HXWI-T-101-INPUT	WIF oil inlet temperature	F	25	☑	150	☑
HXWI-T-301-CALC	WIF shell side temperatu	F	-1E+20	□	1E+20	□
HXWI-UACT	WIF actual heat transfer	Btu/hr-sqft-F	-1E+20	□	1E+20	□
HXWI-UCLEAN	WIF clean exchanger U	Btu/hr-sqft-F	-1E+20	□	1E+20	□
HXWI-UEFF	WIF U efficiency	fraction	-1E+20	□	1E+20	□

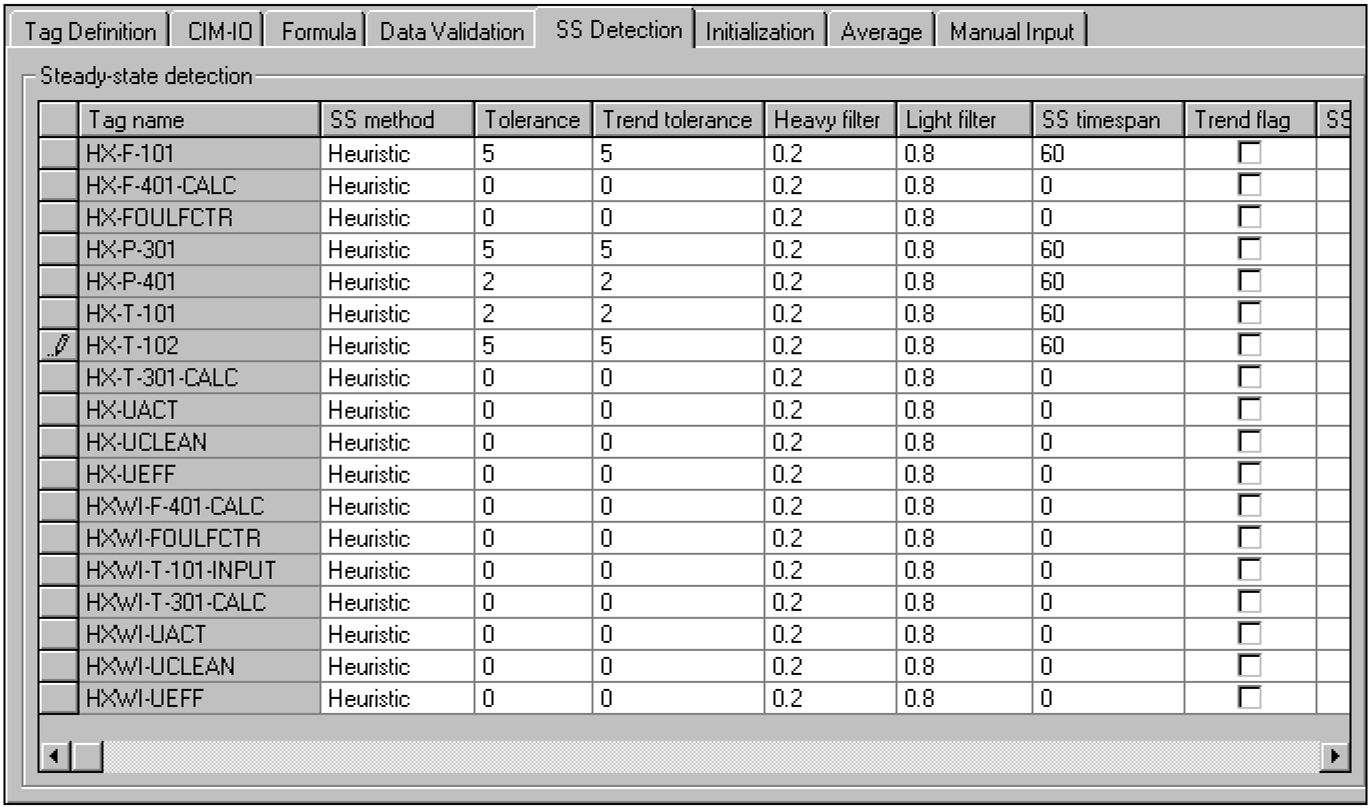
Figure 17: Data Validation sheet

Configure Steady State Detection

The plant must be close to steady-state operation in order to achieve accurate results from Aspen Plus, a steady state simulator. Steady state is determined by monitoring one or more key plant tags. The data for a plant tag selected as a steady state indicator is processed through two filters; one with a short time constant, and the other with a long time constant. The data covers a fixed period of time, usually an hour or two. The largest deviation between the two sets of filtered values is compared to a limit. If the limit is exceeded, then the plant is deemed not to be operating under steady-state conditions. To test for trending data the difference between the starting and ending values of the heavy filter variable are compared to a limit. If the difference exceeds the limit, the process is deemed to be trending.

The heat exchanger example being used in this tutorial uses constant values for the IMS tags. Therefore, steady state detection has not been enforced. Nevertheless, refer to Figure 18 in completing the **SS Detection** sheet.

Steady state detection may be turned on or off using the **Steady state detection required** checkbox in the **Models |** *model name* **| Specifications** sheet.



Tag name	SS method	Tolerance	Trend tolerance	Heavy filter	Light filter	SS timespan	Trend flag	SS
HX-F-101	Heuristic	5	5	0.2	0.8	60	☐	
HX-F-401-CALC	Heuristic	0	0	0.2	0.8	0	☐	
HX-FOULFCTR	Heuristic	0	0	0.2	0.8	0	☐	
HX-P-301	Heuristic	5	5	0.2	0.8	60	☐	
HX-P-401	Heuristic	2	2	0.2	0.8	60	☐	
HX-T-101	Heuristic	2	2	0.2	0.8	60	☐	
HX-T-102	Heuristic	5	5	0.2	0.8	60	☐	
HX-T-301-CALC	Heuristic	0	0	0.2	0.8	0	☐	
HX-UACT	Heuristic	0	0	0.2	0.8	0	☐	
HX-UCLEAN	Heuristic	0	0	0.2	0.8	0	☐	
HX-UEFF	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-F-401-CALC	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-FOULFCTR	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-T-101-INPUT	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-T-301-CALC	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-UACT	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-UCLEAN	Heuristic	0	0	0.2	0.8	0	☐	
HXWI-UEFF	Heuristic	0	0	0.2	0.8	0	☐	

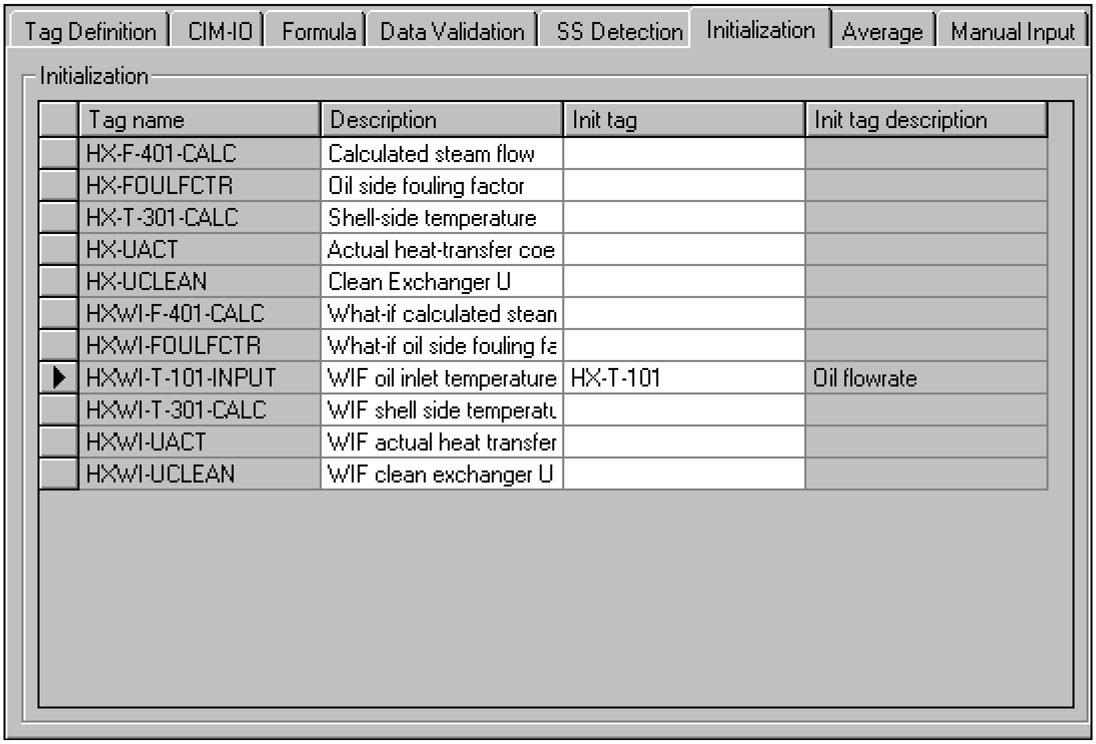
Figure 18: Tags | Grid View | SS Detection sheet

Configure Initialization Form

The What-if application of the Heat Exchanger example is configured to permit users to supply the value of one model input variable at run time on the project screen. This variable is the oil inlet temperature.

Aspen OnLine provides a means for automatically loading the current plant value as a default and then allowing this value to be modified by user input. In the **Tags | Grid View | Initialization** sheet shown in Figure 19, the **Init tag** column provides a list of all tags. Clicking the desired name will cause it to be entered in the **Init tag** column.

Refer to Figure 19 to locate the variable requiring initialization.



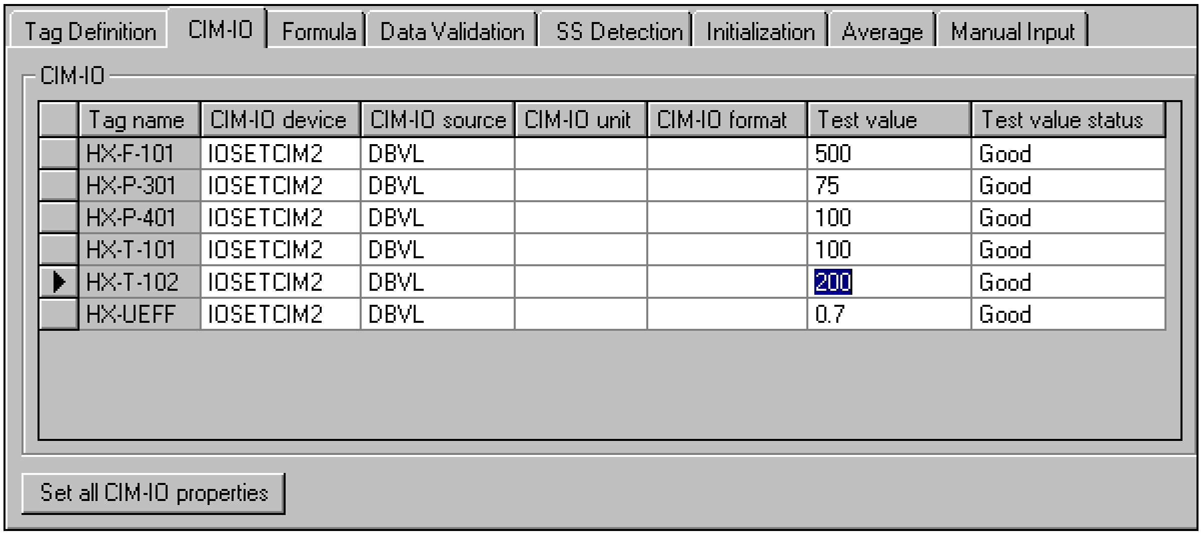
	Tag name	Description	Init tag	Init tag description
	HX-F-401-CALC	Calculated steam flow		
	HX-FOULFCTR	Oil side fouling factor		
	HX-T-301-CALC	Shell-side temperature		
	HX-UACT	Actual heat-transfer coe		
	HX-UCLEAN	Clean Exchanger U		
	HXWI-F-401-CALC	What-if calculated stean		
	HXWI-FOULFCTR	What-if oil side fouling fa		
▶	HXWI-T-101-INPUT	WIF oil inlet temperature	HX-T-101	Oil flowrate
	HXWI-T-301-CALC	WIF shell side temperatu		
	HXWI-UACT	WIF actual heat transfer		
	HXWI-UCLEAN	WIF clean exchanger U		

Figure 19: Tags | Grid View | Initialization sheet

Configure CIMIO Connection

The completed **CIM-IO** sheet is shown below. This information must be provided to establish communications with the plant IMS/DCS. You must specify the **CIM-IO device** from the list. In the case of this tutorial, the CIM-IO device is *IOSETCIM200*.

If you are performing this tutorial without connecting to an IMS or DCS, do not specify **CIM-IO device** and **CIM-IO source** information. Enter test values as shown in the Test Values column. Also, set the **Test value status** to *Good* (the default is *Bad*).



Tag name	CIM-IO device	CIM-IO source	CIM-IO unit	CIM-IO format	Test value	Test value status
HX-F-101	IOSETCIM2	DBVL			500	Good
HX-P-301	IOSETCIM2	DBVL			75	Good
HX-P-401	IOSETCIM2	DBVL			100	Good
HX-T-101	IOSETCIM2	DBVL			100	Good
HX-T-102	IOSETCIM2	DBVL			200	Good
HX-UEFF	IOSETCIM2	DBVL			0.7	Good

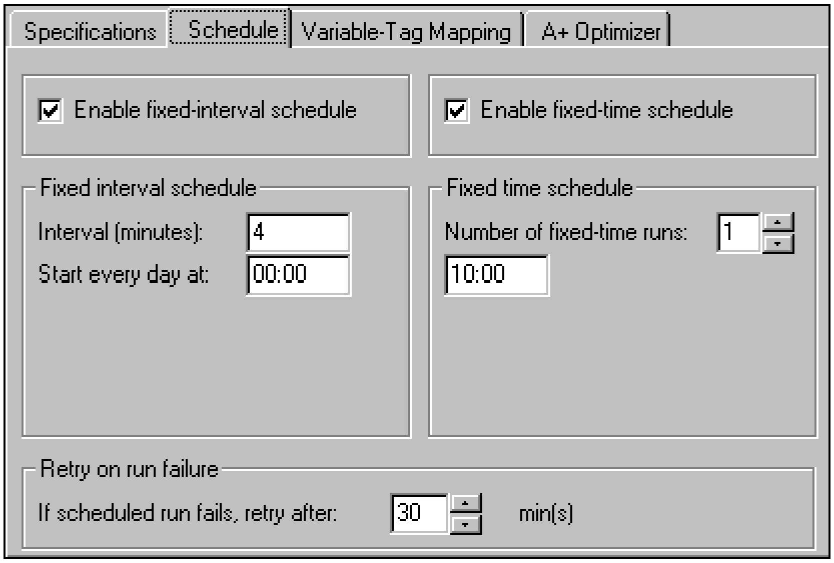
Figure 20: Tags | Grid View | CIM-IO sheet

Configure Automatic Execution of Model Calculations

Information provided in the **Schedule** sheet will be used by Aspen OnLine to execute unattended (user interaction not required) model calculations at specified times and/or intervals during a day. Aspen OnLine can write-back the values of chosen internal application tags to IMS only after the successful completion of scheduled calculations. On-demand calculations will not cause write-back. The heat transfer efficiency value (tag HX-UEFF value) calculated by the Monitor module in Aspen OnLine has already been configured to be written back to IMS. The heat transfer efficiency value stored in the IMS once a day is sufficient for the purpose of monitoring the exchanger performance. However, to illustrate the use of the scheduling feature of Aspen OnLine, a combination of fixed interval scheduling and fixed time scheduling will be configured. The time inputs described below are only an example; any other time schedule can be configured for the unattended calculations. The completed **Schedule** form is shown in Figure 21.

Configure Scheduling of Unattended Model Calculations

Button Sequence	Title of Active Screen	Result
Open the **Models | heatxn1.bkp | Schedule** sheet in the Data Browser.	Models heatxn1.bkp – Data Browser	Enable fixed-time schedule box and Enable fixed-interval schedule box are blank
Select the **Enable fixed-interval schedule** checkbox.		
Enter 4 for **Interval** and enter 30 in the If scheduled run fails, retry after __ min(s) field. When repeating this step for heatxn2.bkp, enter 00:02 in the **Start every day at** field as well.		Model heatxn1.bkp will be executed every 4 minutes starting midnight every day. Model calculations will be retried 30 minutes after a calculation failure (due to data validation and/or steady state detection errors or other errors)
Select the **Enable fixed-time schedule** checkbox and enter 1 for Number of fixed-time runs.		Number of fixed-time runs is now 1. A time input box appears in the Fixed time schedule frame.
Enter 10:00 (10:02 for heatxn2.bkp) in the time input box in the **Fixed time schedule** frame.	Schedule sheet	The heatxn1.bkp model will be automatically executed at 10:00 AM every day. **Note:** any desired time input may be used. To specify a single digit hour, enter a 0 as the first digit. For example, 6:00 PM should be entered as 06:00 PM.
Repeat the above steps for heatxn2.bkp with changes as noted.		



☑ Enable fixed-interval schedule

☑ Enable fixed-time schedule

Fixed interval schedule

Interval (minutes): 4

Start every day at: 00:00

Fixed time schedule

Number of fixed-time runs: 1

10:00

Retry on run failure

If scheduled run fails, retry after: 30 min(s)

Figure 21:Completed Models* | model name | *Schedule sheet for heatxn1.bkp

5 The Graphical User Interface

Steps to Build a GUI

The graphical user interface (GUI) is constructed in two main steps. The first step involves developing diagrams of the key pieces of equipment that are to be displayed, if they are not already in the Graphics Library of Aspen OnLine. The second step involves transfer of these diagrams to the GUI where the appropriate lines, labels, text display boxes, and control buttons are added.

The instructions that follow apply to the Heat Exchanger Monitor module. Construction of the GUI for the What-if module is done the same way with two exceptions. These will be discussed in a separate section.

Initialize the Graphical User Interface

Begin by creating a blank GUI form using the following steps.

Initialize the Graphical User Interface

Button Sequence	Title of Active Screen	Result
Open a Data Browser and click the **User GUI** folder	User GUI – Data Browser	User GUI | Specifications sheet appears.
Click **New.**	New Form	
Enter **Heatx1** as the title of the new form and then click **OK**.	Heatx1 [design]	New Form dialog box is closed and a blank new user GUI form is created and displayed

The first time you create a form, a blank GUI Builder form will appear as shown in Figure 22.

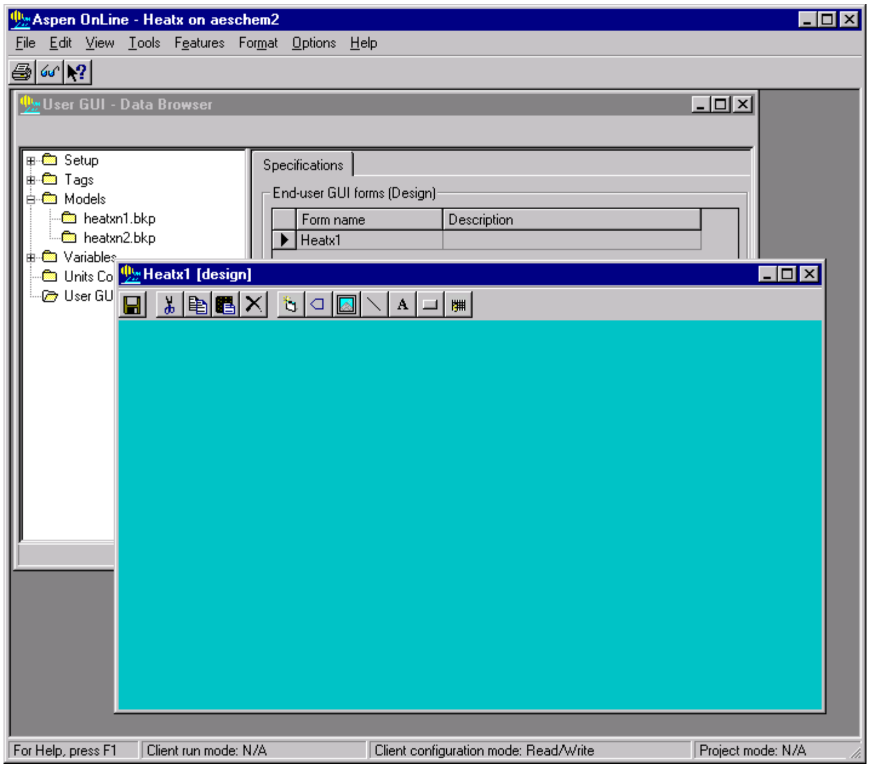


Figure 22: Blank user GUI form displayed in Aspen OnLine Client window

Using the Graphics Library Diagrams

There is a library of common process equipment diagrams that can be imported into the GUI when building a process flow diagram. The library consists of diagram meta files (.wmf). The library is located in the **Graphics Library** folder in the Aspen OnLine installation directory.

When a diagram is imported into the GUI, it may be resized as needed. However, diagrams cannot be flipped or rotated. For this reason a few diagrams are shown as left-and-right or horizontal-and-vertical pairs. A set of arrows is also included that may be used to indicate a feed or discharge flow.

In addition to the meta files, there is a complete collection of PowerPoint (.ppt) equipment diagrams in the library. As needed, you may modify these diagrams, or create entirely new PowerPoint images. PowerPoint images may be copied and pasted into the GUI.

In addition to PowerPoint, many other picture or graphics files can be loaded on the picture object of the Aspen OnLine GUI. Even photographs can be used.

Import Diagram and Add Process Lines

The diagram of the heat exchanger can be imported from the Aspen OnLine Graphics Library.

To do this, in the GUI construction form, open a new image box, import the specified diagram, and paste the diagram in the image box. Relocate the box by dragging it to the desired location with the mouse pointer and then resize by using the sizing handles. Refer to Figure 23 as a guide.

Process lines can only be run from one image to another. In the case of a feed or discharge line, if a feed or discharge arrow is not used, then an empty image box must be created. The line can then connect the equipment piece to the empty image box to produce a feed or discharge line. The empty image box can then be moved to the next location, or deleted. Feed or discharge arrows included in the diagram serve as the second image.

Transfer Heat Exchanger Picture and Add Lines

Button Sequence	Title of Active Screen	Result
Open the **Heatx1 [design]** GUI form window.	Heatx1 [design]	The form is blank.
Click **Tools** menu **| Add Image** and click to place the image box		An image box is added to the form.
With the image box highlighted, click **Tools | Load Picture**.	Open	File selection dialog box appears.
Locate the **Graphics Library** folder in the Aspen OnLine installation directory. Set File Type to Metafiles(*.wmf).		List of diagram files is displayed.
Select **Horizontal 2Pass Exchngr_Left.wmf** and click Open.	Heatx1 [design]	Exchanger diagram is inserted into image box.
Move and resize the image if necessary		Heat exchanger diagram is properly sized and located.
Repeat above to size and locate the steam flow control valve, **Valve_Automatic1.wmf**.		Steam valve properly sized and located
Click **Tools | Add Image**. Place it at the starting point for the Cold oil line.		Empty image box added to form.
Click **Tools | Add Line**.		
Click and hold the mouse button on the empty image box. Drag horizontally to the pipe bend location, then release the button. Click and drag again to the bottom oil flange on the heat exchanger. Double click to release.		Green line with yellow arrows connects empty image box with bottom nozzle on heat exchanger.
Click empty image box.		Empty image box selected.
Either drag to a new location, or click **Edit | Delete.**		Empty image box moved or deleted.
To relocate line, click and drag out a box around all elements of the pipe to select it.		All elements of line are highlighted.
Click on any part of selected line and drag to new location.		Line relocated.
Repeat the steps above for the hot oil line, the inlet steam line, and the condensate line. Valve to preheater line does not require empty image box. Refer to Figure 23 as a guide.		Heat exchanger has two inlet lines, two outlet lines, and a steam flow control valve with an inlet and outlet stream.

Add Labels to Drawing

Labels are easily added to the GUI as illustrated by the following sequence of steps. To build a bulletin board with multiple labels, first create a label box. The label box is then resized to contain all of the labels to be added. Additional label boxes and tags are placed on top of the large label box. Position and size as required.

Add Labels to Drawing

Button Sequence	Title of Active Screen	Result
Open **Heatx1 [design]** GUI form window.	Heatx1 [design]	Heat exchanger diagram displayed.
Click **Tools | Add Label**.		Label function selected.
Move mouse pointer to location for label and click.		Label box appears and is highlighted.
Click right mouse button on the highlighted label box and select **Properties**. Click **Properties** from the menu.		**Label Properties** dialog box appears.
Click **Text** box and type desired text.	Label Properties	Form completed.
Click **OK.**	Heatx1 [design]	Diagram now has label.
Click and drag label to desired location		Label properly positioned.
Repeat the steps above for all labels. Refer to Figure 23 as a guide.		Diagram completely labeled.
Click **File | Save Project.**		Drawing saved.

Add Tags to Drawing

Data associated with tags can easily be displayed on the GUI. However, the tags must have first been defined during the Engine configuration stage. Recall that the Monitor module has output variable tags with the prefix HX-. The What-if module uses HXWI- as the prefix.

Add Plant and Local Tags to Drawing

Button Sequence	Title of Active Screen	Result
Open **Heatx1 [design]** GUI form window.	Heatx1 [design]	Heat exchanger diagram with labels displayed.
Click **Tools | Add Tag**.	Tag Browse	**Tag Browse** window appears on diagram
Click down-arrow next to **Tag Name** box.		List of tag names appears
Click desired tag name.		Name transfers to **Tag Name** box
Click **Display Tag**.	Heatx1 [design]	Text box appears at top left of diagram with units displayed to the right.
Right-click text box again. Click **Number Format** from the menu.	Number Format	Number format dialog box appears.
Enter format information in the form **bbb#.0** where b is a space, # the number, and the zero is a placeholder for the decimal portion of the number.		This is the same format nomenclature used by Microsoft Excel.
Click **OK**.	Heatx1 [design]	Tag name data box with units is displayed.
Click **File | Save Project.**		Drawing saved.

Add Control Buttons to the Drawing

Control buttons must be added to the GUI. This is how the application and model execution are controlled. Control buttons can be setup to run the model, switch to another display screen, read log files, initialize data entry values, etc. Read Log File buttons should be added when setting up the GUI because they are helpful in better understanding the on-line application, the process model, and the process itself.

Adding Buttons to the Drawing

Button Sequence	Title of Active Screen	Result
Open **Heatx1 [design]** GUI form window.	Heatx1 [design]	Heat exchanger diagram with labels displayed.
Click **Tools | Add Button.**		Blank text box appears at pointer.
Move box to desired location and click.		Button appears.
Right click the new button. Click **Properties** from the menu.	Button Properties	**Button Function** scroll appears.
Click **Button Function** down arrow. Select **Run Model** from the menu.		Button caption box filled with Run Model, Number of models set at 1, and Model 1 Name box is blank.
Edit the **Button caption**.		Run Model becomes Run HX Model.
Click **Model 1 Name** box down-arrow.		Model name appears.
Select model name and click **OK**.	Heatx1 [design]	Button shown with label.
Repeat these steps to add **Read Event Log**, Read Run Log, Exit with Save, and Go to What If buttons.		All buttons added to diagram.
Click **File | Save Form.**		Drawing saved and GUI configuration is complete.
Close the **Heatx1 [design]** form.	User GUI – Data Browser	User GUI | specifications sheet is displayed.

The Completed Heatx1 GUI

The completed Heatx1 GUI is shown in Figure 23. All of the elements seen on the diagram were created using the GUI Builder with the exception of the exchanger and the valve, which were imported from the Graphics Library.

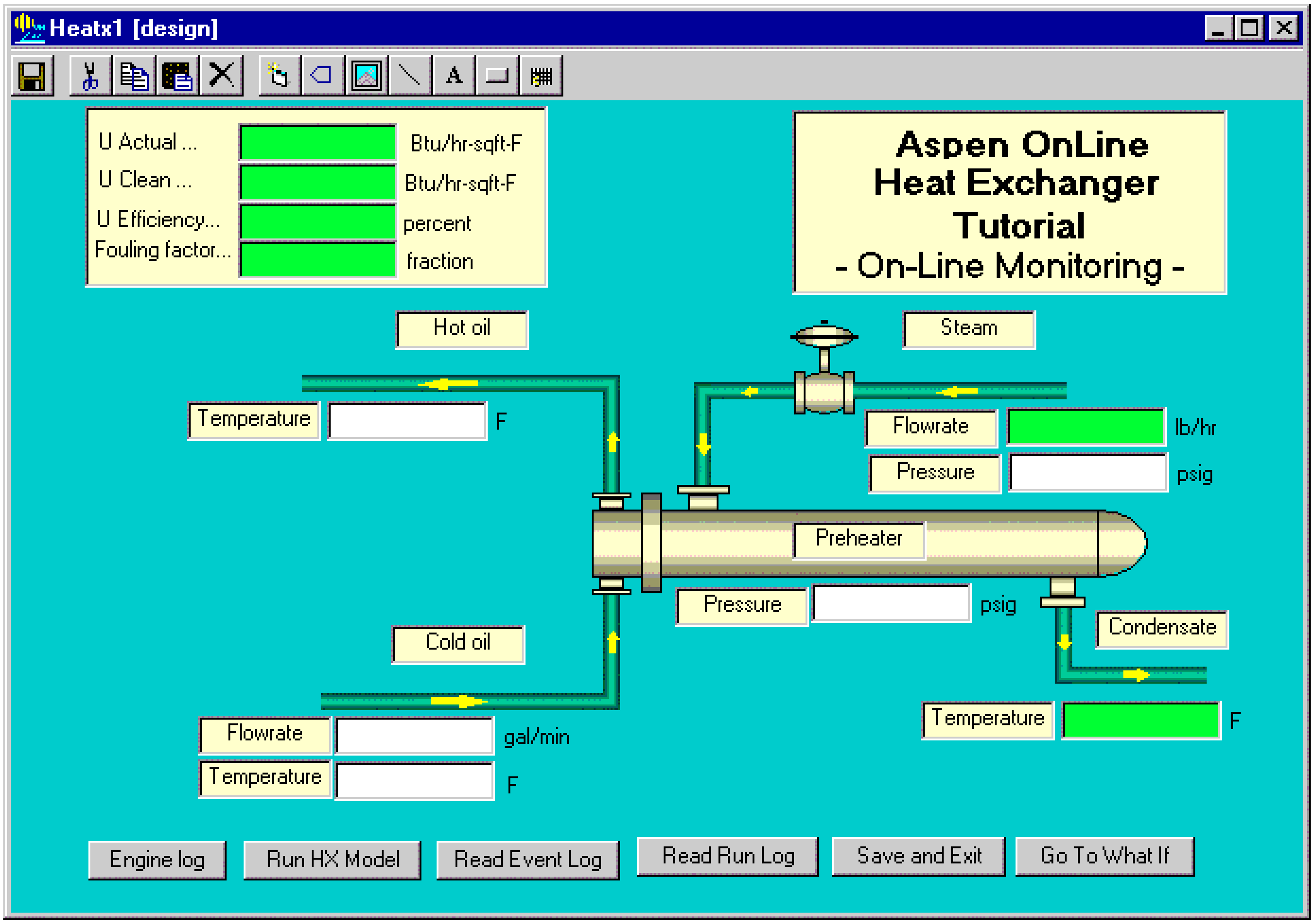


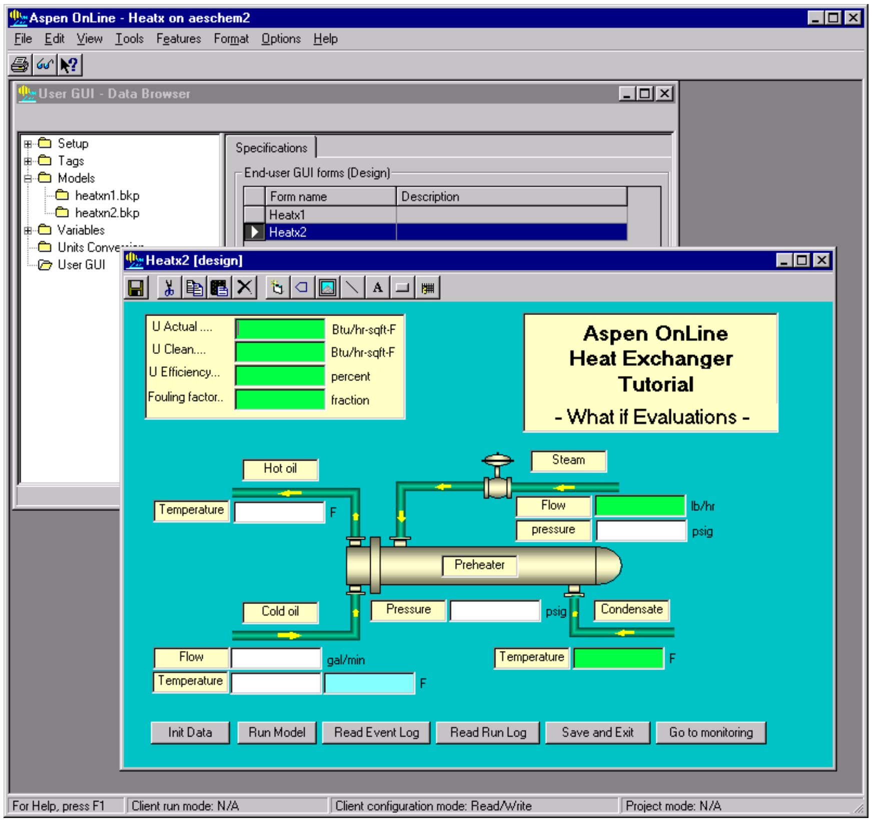
Figure 23: Completed Heat Exchanger Monitor Diagram in the GUI Builder

Creating the What-if GUI (Heatx2)

The GUI for the What-if model is identical to the Heatx1 GUI with two exceptions. First, one data entry tag must be added to the diagram for the oil inlet temperature. This box is added to the diagram in the same manner as all of the other data boxes. It represents the input variable that was defined on the **Tag Definition** form, HXWI-T-101-INPUT. This tag was linked to the What-if model, instead of the plant input variable tag HX-T-101, as was the case with the Monitoring model, Heatx1.

The second difference involves the addition of a data initialization button. In the **Initialization** form the tag HXWI-T-101-INPUT is initialized by HX-T-101. However, the initialization can occur only when the **Init Data** button is clicked.

The completed Heatx2 GUI is shown in Figure 24.



Form name	Description
Heatx1	
Heatx2	

Figure 24: Completed Heat Exchanger What-if Diagram in the GUI Builder

6 Running the Application

Application Execution

At this point, we have made all necessary specifications for this sample project to run. If this project needs to run in test mode (without connecting to plant IMS), you should disable the Aspen CIM-IO Interfaces connection. Open a Data Browser and go to the **Setup | Specifications | CIM-IO** sheet. Select the **Disable CIM-IO** check box.

Close all Data Browsers and all user GUI forms in design mode. Then, follow the instructions below.

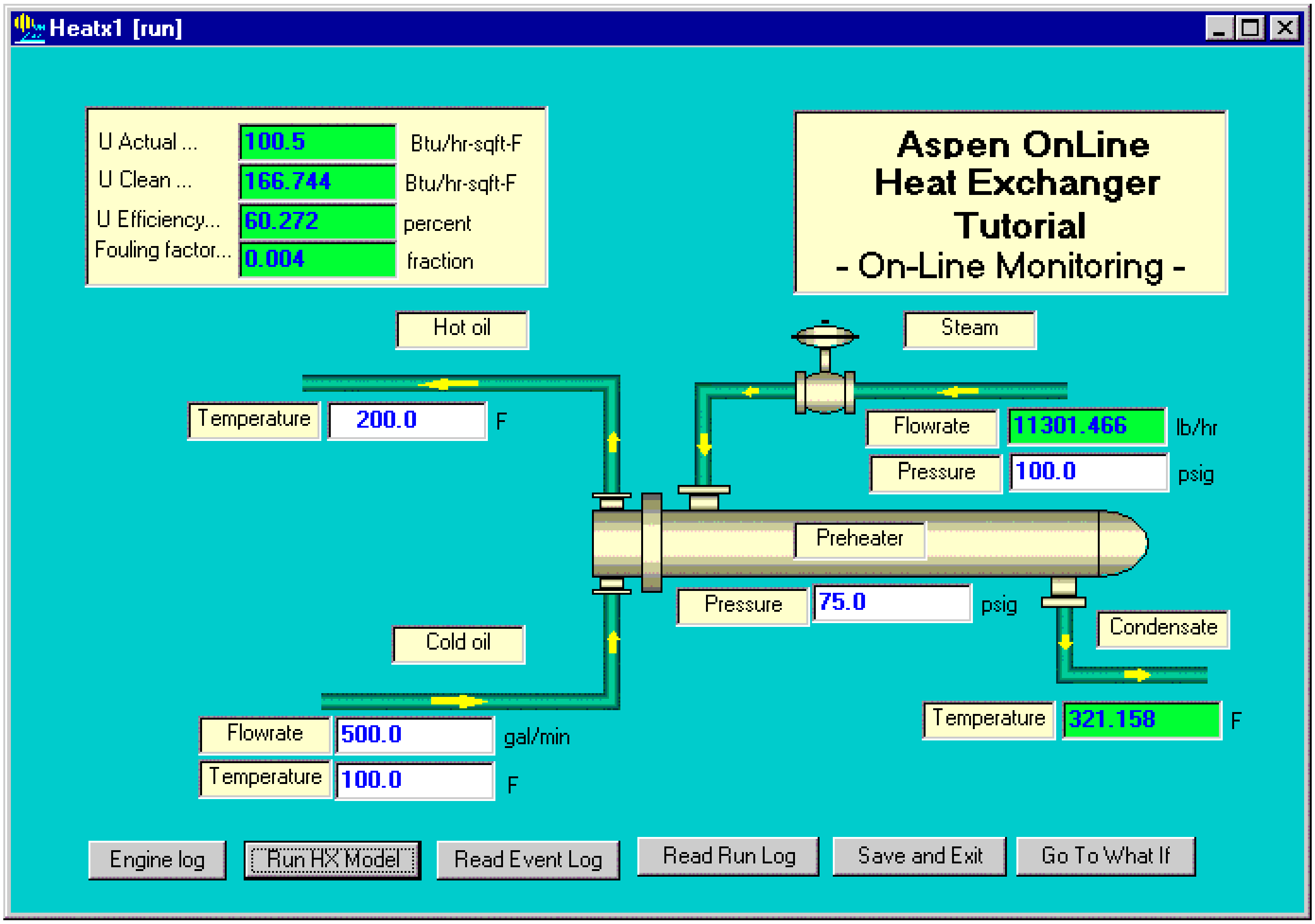
Run Model

Button Sequence	Title of Active Screen	Result
Click **View** menu | **Control Panel** command.	Control Panel	**Control Panel** is displayed in Aspen OnLine Client GUI window.
On **Status** sheet, in steady-state detection frame, click Load.		Steady-state detection program is loaded and some command buttons are enabled.
Click **Start** in same frame.		Steady-state detection program starts.
In **Aspen OnLine engine** frame, click Load.		Aspen OnLine engine program is loaded.
Click **Start** in same frame.		Aspen OnLine engine program starts.
Click **Engine** tab in Control Panel.		Note that heatxn1.bkp and heatxn2.bkp run every 4 minutes alternately. These are scheduled runs.
Click **Run-Time User GUI** tab in Control Panel.		User GUI forms are listed in the list view. These are run-time forms. The **Session option** is **Engine watch**.
Select **Interactive** option.		Now the Session option is Interactive..
Double-click the **Heatx1** form.	Heatx1 [run]	Displays the run-time Heatx1 GUI.

Button Sequence	Title of Active Screen	Result
Click **Run HX Model**.	heatxn1.bkp is running	Three messages in turn are displayed: Analyzing data … Initializing model … Model is running …
	heatxn1.bkp is running	Message is: **Model is running**
		Message disappears.
Click **Read Event Log**.	EventLog.log - notepad	Should be clear of messages.
Click **Read Run Log**.	RunLog1.log - notepad	Should list the values of the input and output variables displayed on the GUI.
Click **Go to What If.**	Heatx2 [run]	Displays the run-time Heatx2 GUI.
Click **Init Data**.		Current values of inlet temperature, **100 F**, fills the input data boxes.
Click **Run Model**.		Should produce results identical to those obtained for Heatx1.
Enter **85** for the Cold oil temperature. Click **Run Model.**		Results should match those shown in Figure 26.
Click **Status** tab in Control Panel and click **Unload** in **Steady-state detection** frame.	Control Panel	Run-time user GUI forms are closed and steady-state detection program and Aspen OnLine engine program are stopped and unloaded.
Click **File** menu | **Exit** command.	Desktop	Congratulations! You have successfully completed your first on-line model application.

Results of OnLine Model Calculations

Figures 25 and 26 display the results for the Monitoring model and the What-if model, respectively.



Heatx1 [run]

U Actual ... 100.5 Btu/hr-sqft-F

U Clean ... 166.744 Btu/hr-sqft-F

U Efficiency... 60.272 percent

Fouling factor... 0.004 fraction

Aspen OnLine Heat Exchanger Tutorial - On-Line Monitoring -

Hot oil: Temperature 200.0 F

Steam: Flowrate 11301.466 lb/hr

Steam: Pressure 100.0 psig

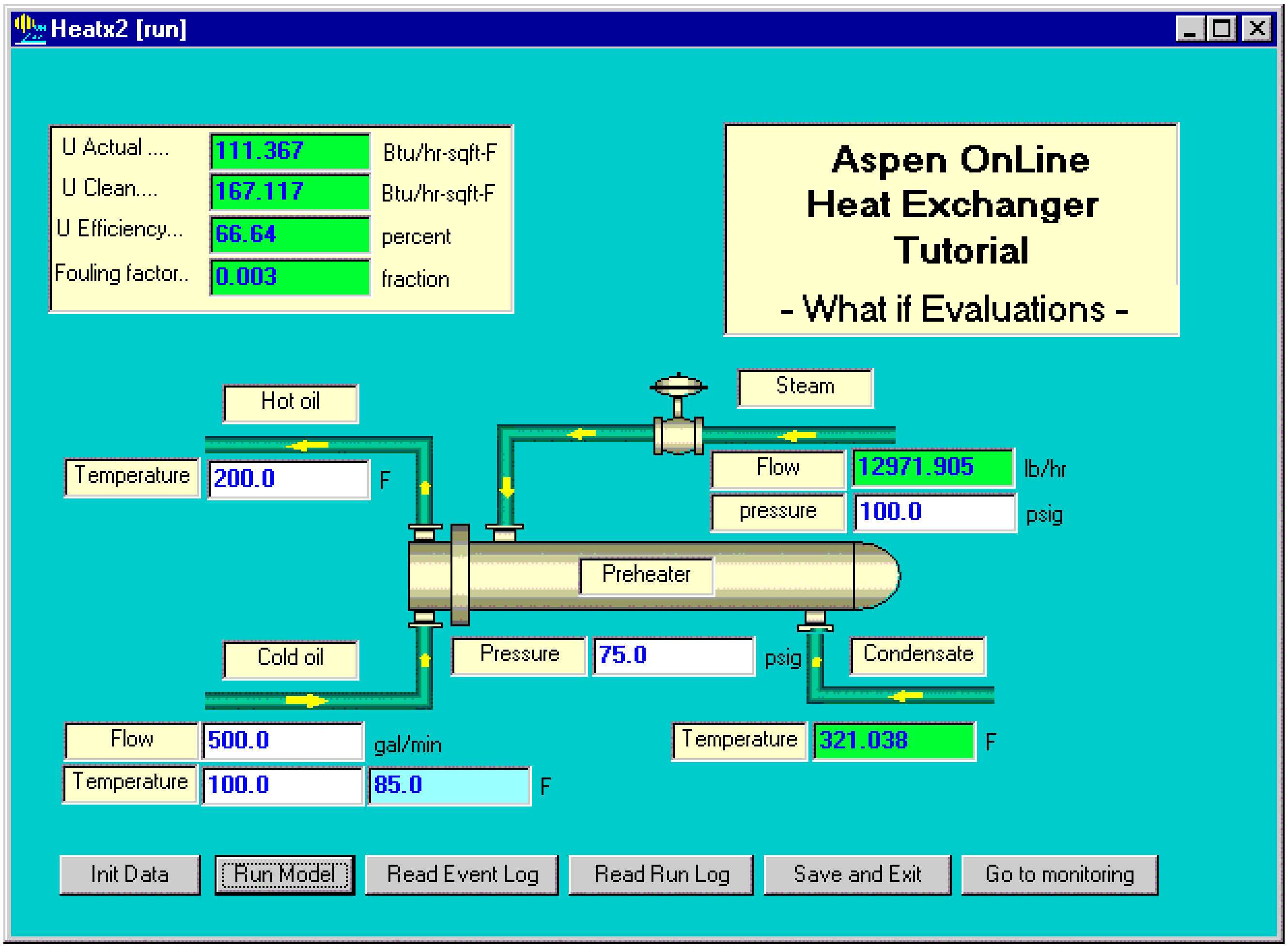
Preheater: Pressure 75.0 psig

Condensate: Temperature 321.158 F

Cold oil: Flowrate 500.0 gal/min

Cold oil: Temperature 100.0 F

Figure 25: Heat Exchanger Monitor GUI with Results



Heatx2 [run]

U Actual .... 111.367 Btu/hr-sqft-F

U Clean.... 167.117 Btu/hr-sqft-F

U Efficiency... 66.64 percent

Fouling factor.. 0.003 fraction

Aspen OnLine
Heat Exchanger
Tutorial

- What if Evaluations -

Hot oil

Temperature 200.0 F

Steam

Flow 12971.905 lb/hr

pressure 100.0 psig

Pressure 75.0 psig

Condensate

Temperature 321.038 F

Cold oil

Flow 500.0 gal/min

Temperature 100.0 85.0 F

Figure 26: Heat Exchanger What-if GUI with Results