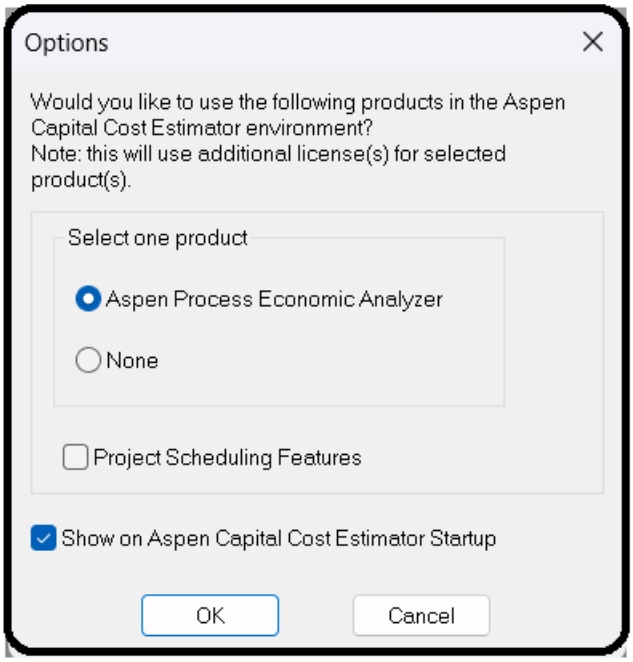
Part 13

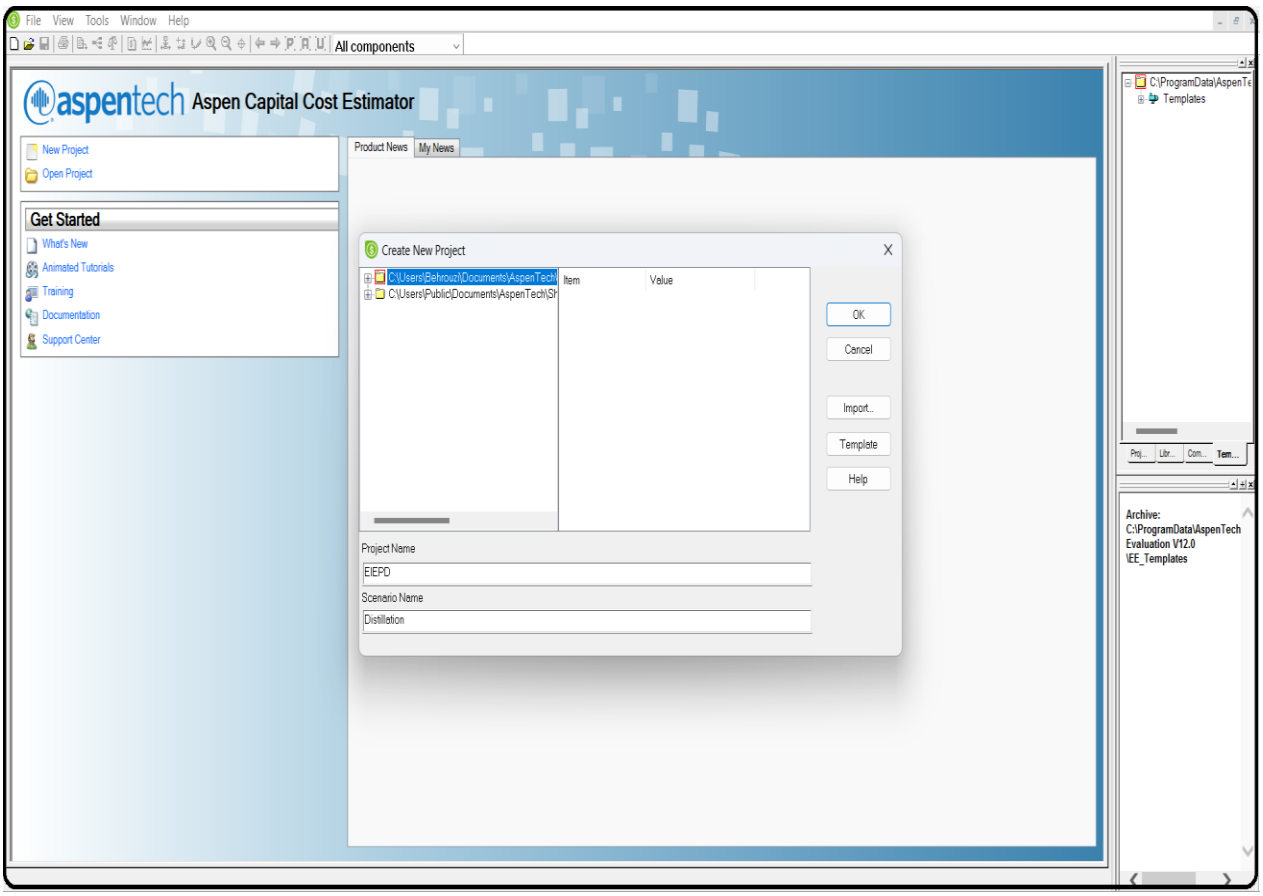
Aspen Capital Cost Estimator

USING ASPEN CAPITAL COST ESTIMATOR AS A STAND-ALONE PRODUCT

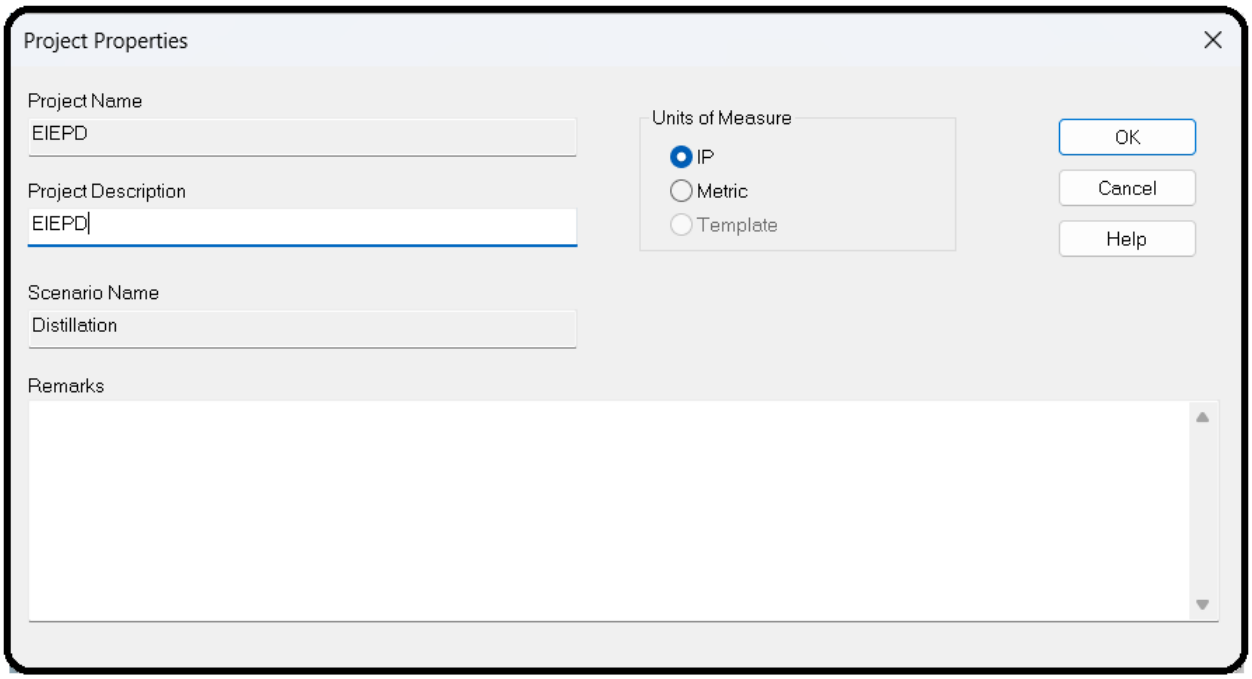
Aspen Capital Cost Estimator is a beastly program, weighing in at a few gigabytes and containing an incredible amount of in-depth knowledge. Its purpose is to estimate the capital costs of common chemical process equipment. Costs are computed using a large database of detailed models of individual pieces of equipment, which is the most accurate method of estimation possible in the early stages of process design short of getting actual quotes. Other more traditional correlations are used to fill in the gaps in the data. Estimates are significantly detailed, which include labor costs to install (it varies depending on which part of the country/world you are in), what kind of ground you are putting it on (rocks? cement?), and
how much paint you need for the outside. It also literally has a section called “nuts and bolts.”
There are generally two ways to use the software. In this part, we will use the first way which is as a stand-alone product: Launch Aspen Capital Cost Estimator. It’s not going to look anything like Aspen Plus. When it loads, it will ask you if you want to also load the Aspen Process Economic Analyzer (Yes).



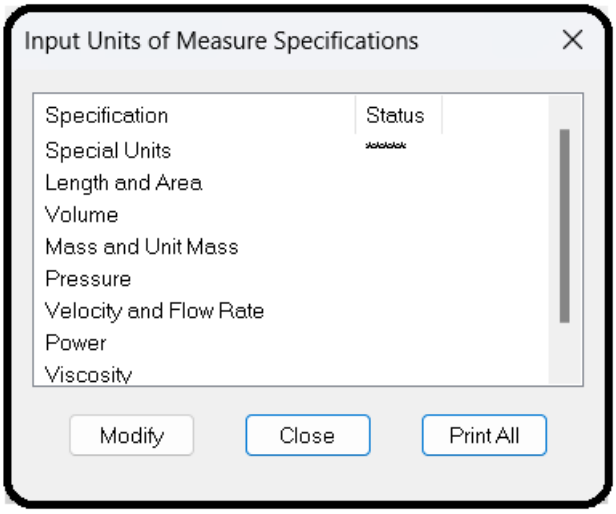
First, you create Projects. A Project is basically a collection of pieces of equipment that are in your chemical plant. We'll start by creating a new project. If the default folder is no good for you, go to Tools | Options | Preferences | Locations and then Add your preferred directory to the list. Now, create a new project (File | New), pick a name, and put it in your new folder (see Figure 10.1).



Then on the next screen, select IP units. The default, IP, is inchpound (also called "imperial"). Note that most American and Canadian companies still use IP for process equipment. For example, distillation columns are bought with diameters in standard sizes of 6-in. increments. If you want something that is 1 m in diameter (3 ft. 3.3 in.), that is a very expensive custom order.



Once you create the new project, you are immediately presented with a request to modify the "Input Units of Measure Specifications," as shown in Figure 10.2. Click on one, say Length and Area, and click Modify. This shows you the default measurements, as shown in Figure 10.3. You could, if you wanted, enter your own units here and a conversion. For example, if you want *pinky lengths* wherever inches are normally used, you could enter that here and put in the appropriate conversion amount. Let's not do this.

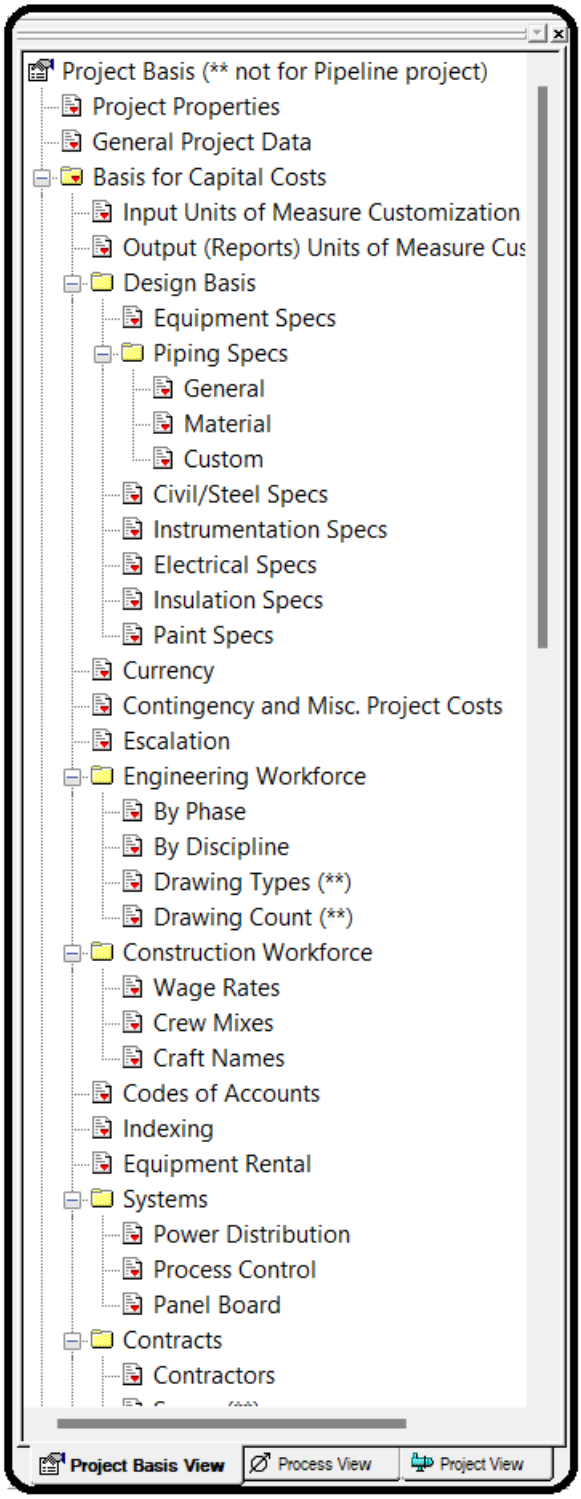


After this (cancel and close), you are presented with the General Project data screen (see Figure 10.4). Here are defaults such as

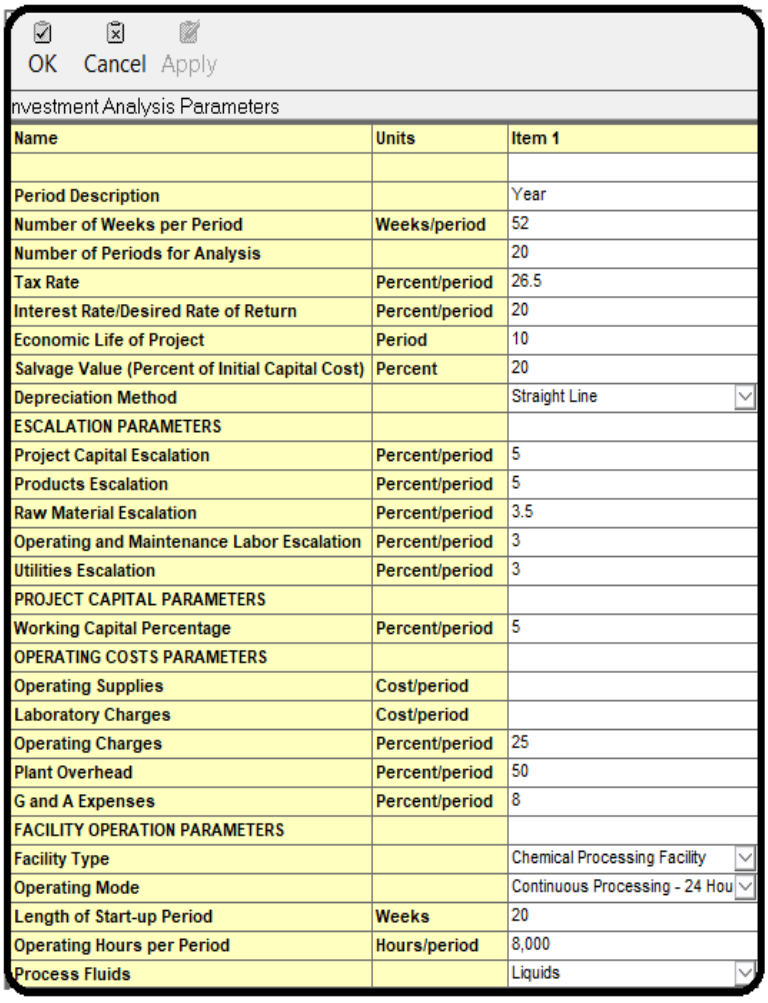
Name	Units	Item 1
GENERAL INFORMATION		
Units of Measure		I-P
Project Country Base		US
Project Currency Name		DOLLARS
Project Currency Description		U.S.DOLLARS
Project Currency Symbol		USD
Project Currency Conversion Rate		1
Country Base Currency		*USD*
Project Title		
Project Location		North America
Estimate Class		
Job Number		
Prepared By		
ESTIMATE DATE		
Estimate Day		
Estimate Month		
Estimate Year		
Allow Pipeline Areas		
Suppress default equipment/area/project bulks		
Estimate Basis for Unit Rates		N

currency units, region, etc. We want to choose the United States as the Base country. In other words, all of their cost data are taken from American chemical plants and applications. However, suppose we are a Canadian company who will build this plant in Ontario, Canada, and thus prefer to work in Canadian dollars. For convenience, you can change the currency description, symbol, and conversion rate. Enter in whatever today's exchange rate is or whatever you normally use for cost budgeting. For example, if you want to use the same number I did, 1.278 CAD = 1 USD, December 5, 2020, then type 1.278 in the box for Currency Conversion Rate, as shown in Figure 10.4. Update the description and other fields as necessary. At the bottom, enter the date at which you intend to purchase the plant (let's say January 1, 2021). It doesn't actually matter what the date is as far as the costs are concerned, but this is useful to make things easier to follow in other parts of the software.

Click OK. You are next shown the regular workspace screen. On the left column of your regular workspace screen, there are three tabs at the bottom. Choose the first tab (Project Basis View), as shown in Figure 10.5.

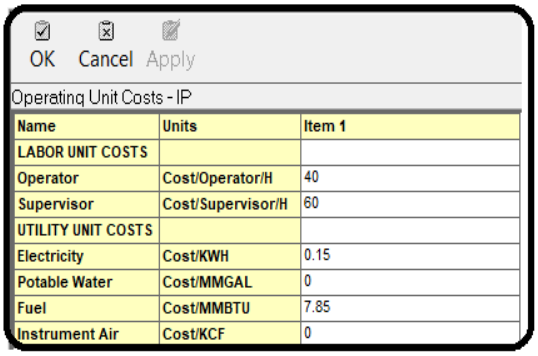

Project Basis (** not for Pipeline project)
Project Properties
General Project Data
Basis for Capital Costs
Input Units of Measure Customization
Output (Reports) Units of Measure Cus
Design Basis
Equipment Specs
Piping Specs
General
Material
Custom
Civil/Steel Specs
Instrumentation Specs
Electrical Specs
Insulation Specs
Paint Specs
Currency
Contingency and Misc. Project Costs
Escalation
Engineering Workforce
By Phase
By Discipline
Drawing Types (**)
Drawing Count (**)
Construction Workforce
Wage Rates
Crew Mixes
Craft Names
Codes of Accounts
Indexing
Equipment Rental
Systems
Power Distribution
Process Control
Panel Board
Contracts
Contractors
Project Basis View
Process View
Project View

It is here that you can specify many more things. For example, go down to the Project Basis | Investment Analysis | InvestmentParameters tab and double-click on it. Here we can change the key economic parameters like tax rate, desired rate of return, depreciation methods, etc. Change the tax rate from 40% (a typical U.S. amount is 35% federal + 5% state but it varies by state) to 26.5% (a typical amount is 15% Canada Federal + 11.5% Ontario Provincial) and click OK. Also, as we are assuming Canadian costs, we also need to bump our labor costs up. Double-click the Project Basis | Investment Analysis | Operating Unit Costs tab and bump operators from 20 to 40 $/hr and supervisors to 60 $/hr (again these are Canadian dollars). Also, set the electricity price to 15 ¢/kWh (0.15 $/kWh), which was the average Ontario's mid-peak price at the end of 2020, and click OK.


OK Cancel Apply

nvestment Analysis Parameters

Name	Units	Item 1
Period Description		Year
Number of Weeks per Period	Weeks/period	52
Number of Periods for Analysis		20
Tax Rate	Percent/period	26.5
Interest Rate/Desired Rate of Return	Percent/period	20
Economic Life of Project	Period	10
Salvage Value (Percent of Initial Capital Cost)	Percent	20
Depreciation Method		Straight Line
ESCALATION PARAMETERS		
Project Capital Escalation	Percent/period	5
Products Escalation	Percent/period	5
Raw Material Escalation	Percent/period	3.5
Operating and Maintenance Labor Escalation	Percent/period	3
Utilities Escalation	Percent/period	3
PROJECT CAPITAL PARAMETERS		
Working Capital Percentage	Percent/period	5
OPERATING COSTS PARAMETERS		
Operating Supplies	Cost/period	
Laboratory Charges	Cost/period	
Operating Charges	Percent/period	25
Plant Overhead	Percent/period	50
G and A Expenses	Percent/period	8
FACILITY OPERATION PARAMETERS		
Facility Type		Chemical Processing Facility
Operating Mode		Continuous Processing - 24 Hou
Length of Start-up Period	Weeks	20
Operating Hours per Period	Hours/period	8,000
Process Fluids		Liquids

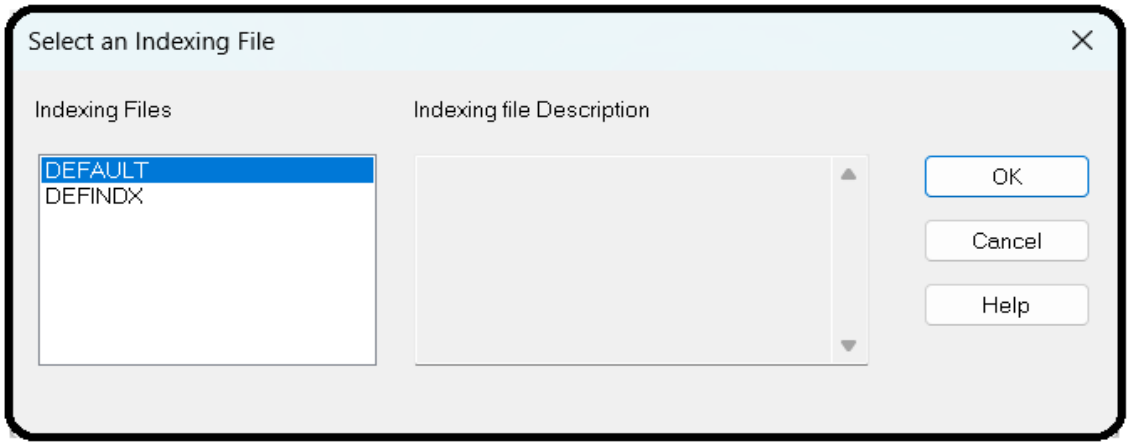

OK Cancel Apply

Operating Unit Costs - IP

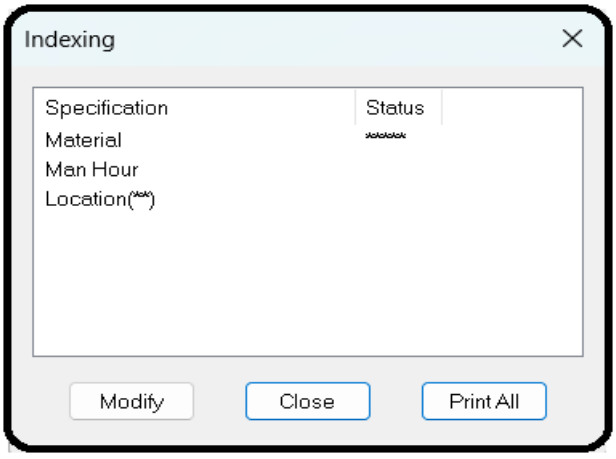
Name	Units	Item 1
LABOR UNIT COSTS		
Operator	Cost/Operator/H	40
Supervisor	Cost/Supervisor/H	60
UTILITY UNIT COSTS		
Electricity	Cost/KWH	0.15
Potable Water	Cost/MMGAL	0
Fuel	Cost/MMBTU	7.85
Instrument Air	Cost/KCF	0

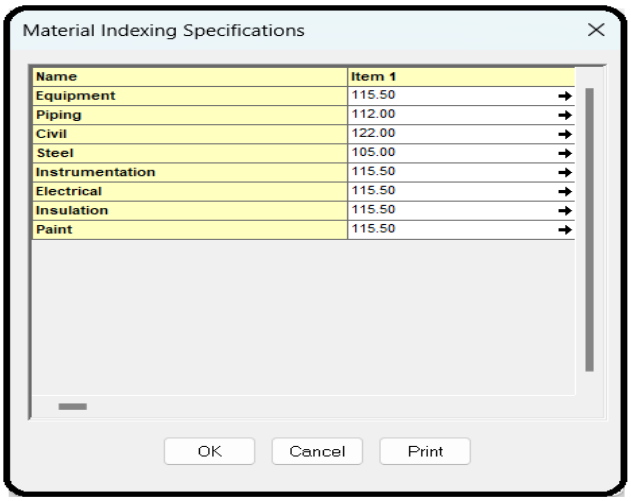
Similarly, we can change the cost indexing, that is, how much more we have to pay than the base cost due to inflation and changes in the market. In the version used in this edition (V12), the base costs in the database are for the first fiscal quarter of 2019, and you can check yourself by looking in the title bar of the window of the program when you first open it. Because we left the Project Country Base as the United States, it will use its database of prices for things sold in the United States in the first quarter of 2019. If we wanted, the program also has databases for the United Kingdom, Japan, the European Union, or the Middle East as well. Let's assume that right now in the first quarter of 2021, Americans have to pay 5% more for equipment than they did in 2019, and Canadians have to pay 10% more than in the United States even adjusting for the exchange rate. This means that we are assuming that our 2021 Canadian costs are 1.1 × 1.05 = 1.155 (or 15.5%) more than the basis costs for the United States in 2019. Aspen Plus defines the base factor as 100 for the base case. So for a 15.5% increase in cost, we need to change the index for equipment to 115.5.

Right-click on Project Basis | Basis for Capital Costs | Indexing and choose Select. You are picking between different index files. Just pick the default and click OK; it's too complex to go into this further.



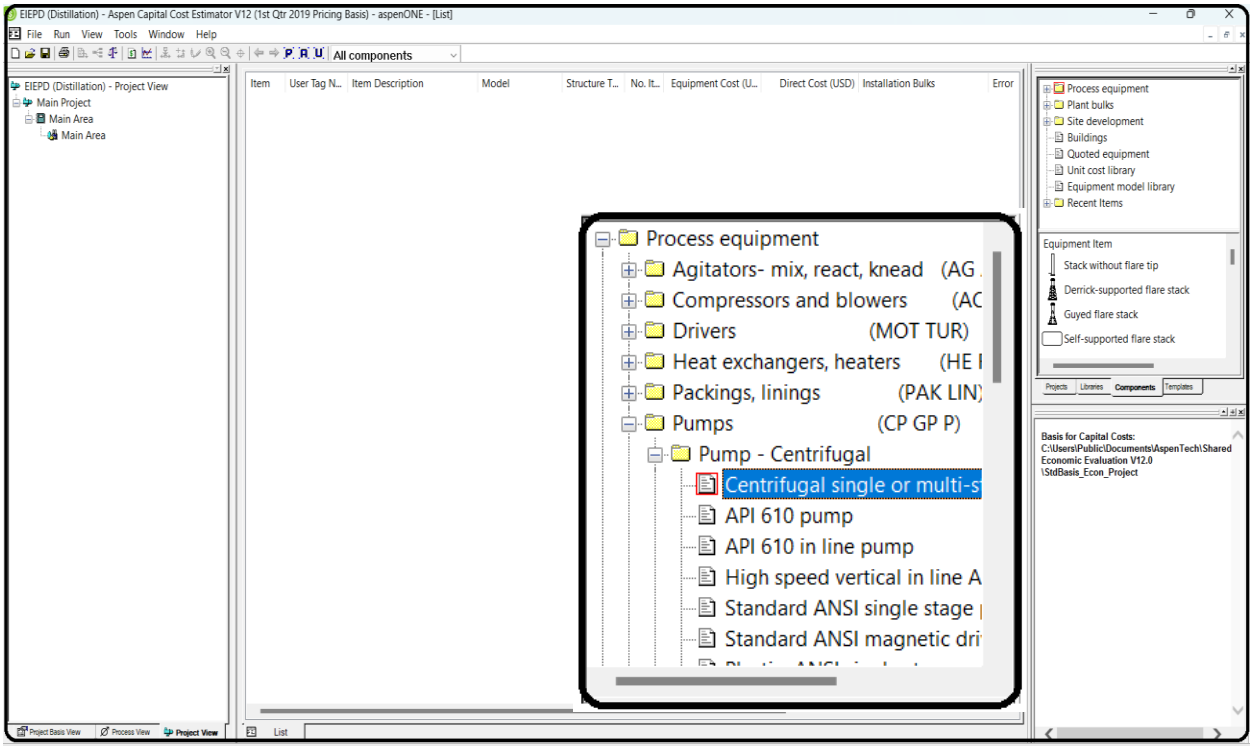
Now right-click Basis for Capital Costs | Indexing item again, choose Edit, as shown in Figure 10.6. Select Material and hit Modify.



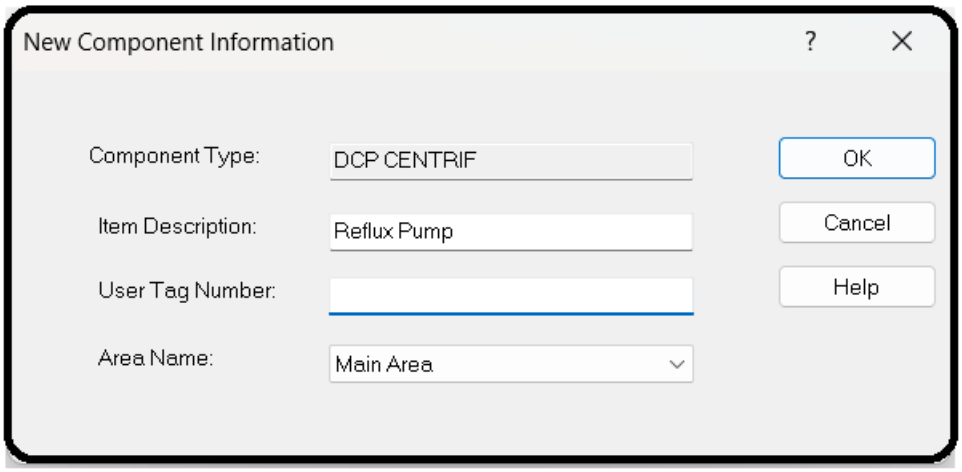


Now you can see that “100” is the basis for all of these, so change Equipment to 115.5. Modify the rest and say that Piping should be 12% higher, Civil is 22% higher, Steel is only 5% higher, and all the rest are 15.5% higher,2 as shown in Figure 10.7. Then click OK and Close.

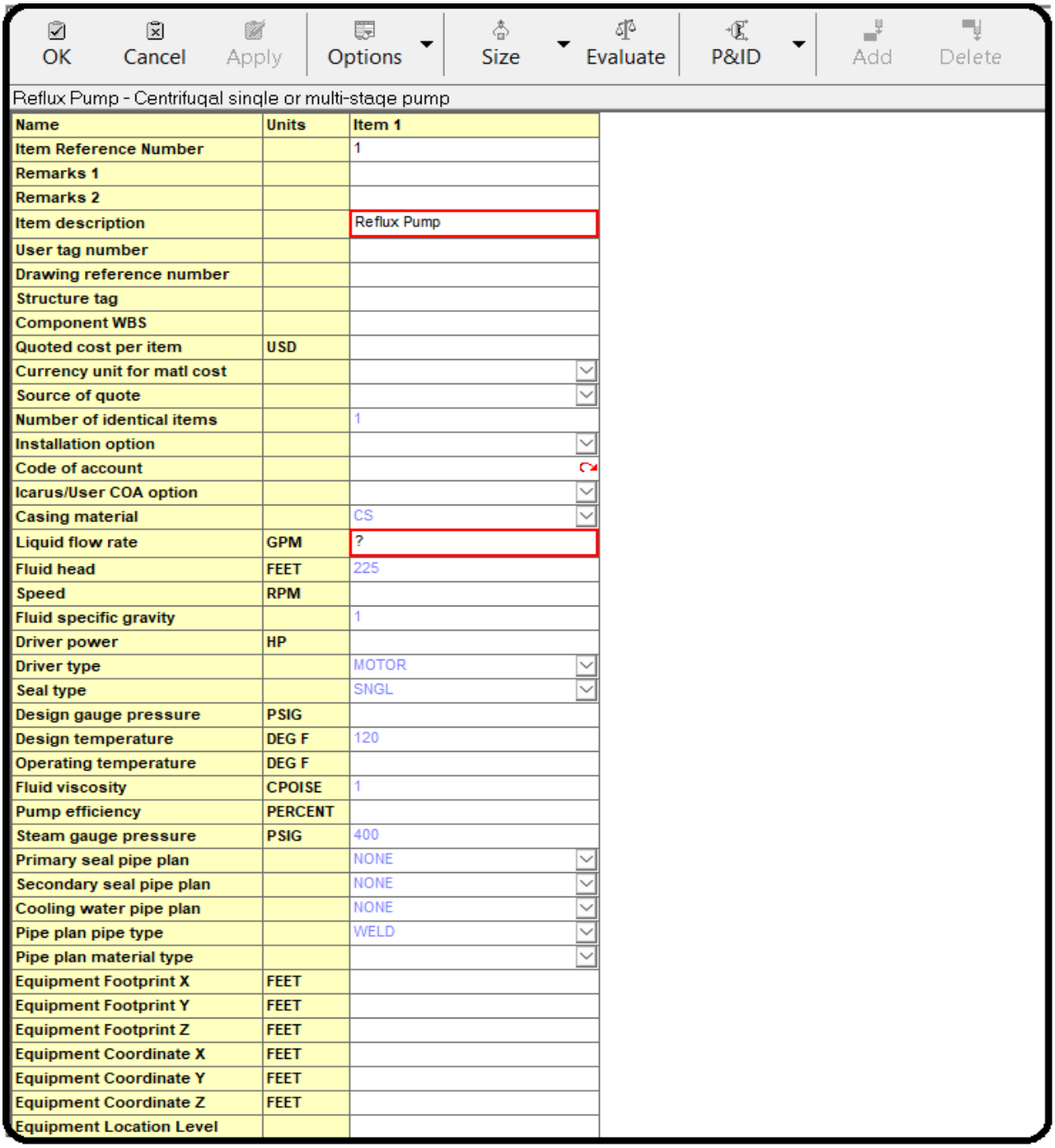
Now that the base cost information is added, we can start adding and costing equipment to our plant. Switch to the Project View tab (third on the bottom right of the left column). It will show that you have a Main Area inside of your Main Project. Projects are like folders, you just group everything you are working on into one or more projects. Areas are geographical areas of your chemical plant, as in maybe the west wing of your factory, or some fenced-in place outside, etc. You assign pieces of equipment3 to an Area. On the right window pane, you should see the tab options for Projects, Libraries, Components, and Templates. Go to the Components tab. This is where all of the equipment models are located. Start by adding a Centrifugal single or multi-stage pump, as shown in Figure 10.8. You’ll find it under Process equipment | Pumps | Pump-Centrifugal | Centrifugal single or multi-stage pump. To add it, drag and drop the icon into the whitespace in the middle column.



Give it a name such as Reflux Pump for the Item description. You are now presented with a form where you can fill in all sorts of information to ridiculous levels of detail, as shown in Figure 10.9.



The red boxes are items which must be entered before proceeding. The boxes with blue text are items which must be entered for Icarus to calculate the cost, but have a default option selected for you. The empty boxes are optional but can also be factored into the cost if you have that information available. For this pump, change the casing material to stainless steel and update the flow rate, fluid head, and design gauge pressure according to the diagram on the next page. When ready, click OK. Your middle column on the main view should have something similar to Figure 10.10.



OK | Cancel | Apply | Options | Size | Evaluate | P&ID | Add | Delete

Reflux Pump - Centrifugal single or multi-stage pump

Name	Units	Item 1
Item Reference Number		1
Remarks 1		
Remarks 2		
Item description		Reflux Pump
User tag number		
Drawing reference number		
Structure tag		
Component WBS		
Quoted cost per item	USD	
Currency unit for matl cost		
Source of quote		
Number of identical items		1
Installation option		
Code of account		
Icarus/User COA option		
Casing material		CS
Liquid flow rate	GPM	?
Fluid head	FEET	225
Speed	RPM	
Fluid specific gravity		1
Driver power	HP	
Driver type		MOTOR
Seal type		SNGL
Design gauge pressure	PSIG	
Design temperature	DEG F	120
Operating temperature	DEG F	
Fluid viscosity	CPOISE	1
Pump efficiency	PERCENT	
Steam gauge pressure	PSIG	400
Primary seal pipe plan		NONE
Secondary seal pipe plan		NONE
Cooling water pipe plan		NONE
Pipe plan pipe type		WELD
Pipe plan material type		
Equipment Footprint X	FEET	
Equipment Footprint Y	FEET	
Equipment Footprint Z	FEET	
Equipment Coordinate X	FEET	
Equipment Coordinate Y	FEET	
Equipment Coordinate Z	FEET	
Equipment Location Level		

Item	User Tag N...	Item Description	Model	Structure T...	No. It...	Equipment Cost (U...	Direct Cost (USD)	Installation Bulks
1		Reflux Pump	CP CENTRIF					

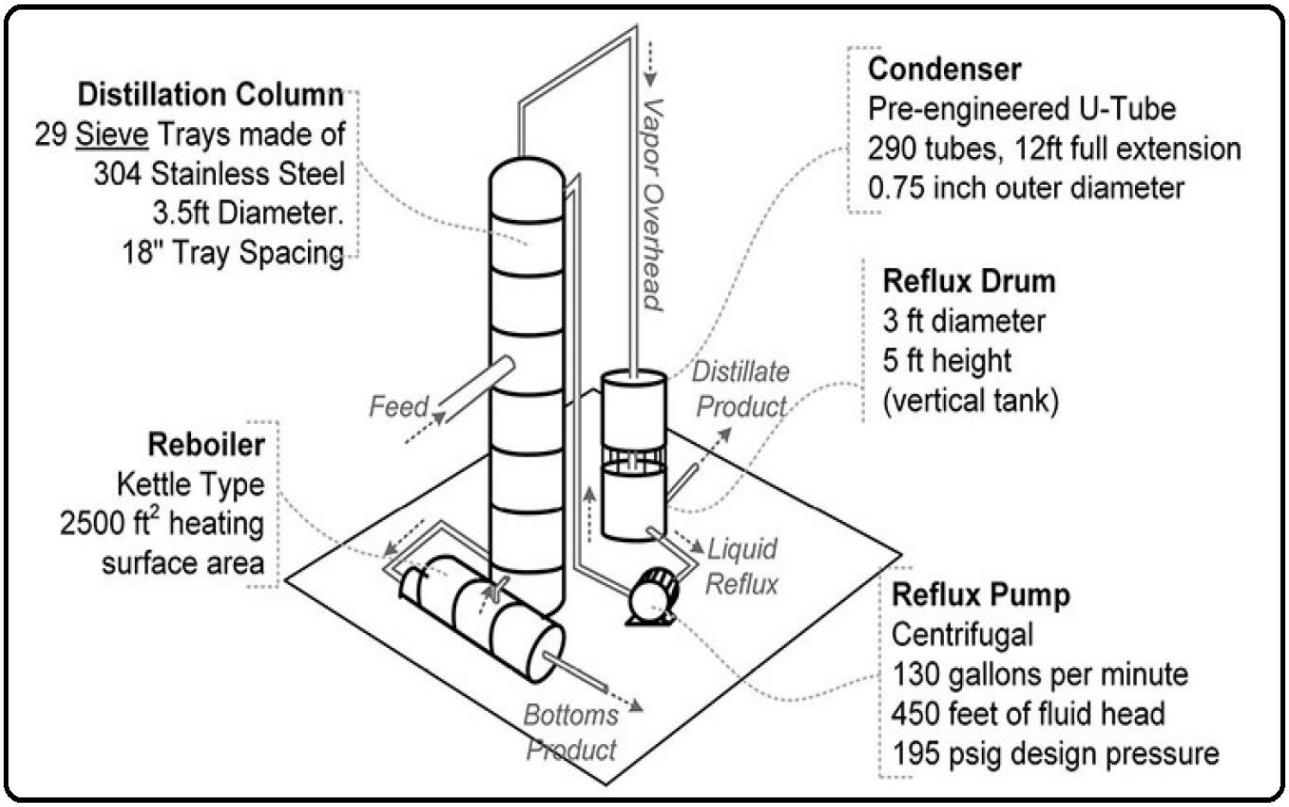
Now, let's ask the program to compute the cost. Right-click on the pump in the item list, and choose Evaluate Item. ACCE will run something and produce an Item Report. Scroll down to the bottom, and see the equipment summary. You should see something similar to Figure 10.11.

	:---MATERIAL---:	*** M A N P O W E R ***:		L/M RATIO :
	: CAD :	CAD	MANHOURS	:CAD/CAD :
EQUIPMENT&SETTING	: 40200. :	2422.	54	: 0.060 :
PIPING	: 18969. :	6736.	156	: 0.355 :
CIVIL	: 818. :	1401.	41	: 1.713 :
STRUCTURAL STEEL	: 0. :	0.	0	: 0.000 :
INSTRUMENTATION	: 419. :	124.	3	: 0.295 :
ELECTRICAL	: 1931. :	2104.	49	: 1.089 :
INSULATION	: 0. :	0.	0	: 0.000 :
PAINT	: 0. :	0.	0	: 0.000 :
SUBTOTAL	: 62336. :	12786.	303	: 0.205 :
INSTALLED DIRECT COST	75100.	INST'L COST/PE RATIO	1.868	

You can see that while the actual pump itself costs $40,200 (CAD), it costs $2,422 to install and required 54 worker-hours4 to do so. Then, there is the piping to connect it to the other parts of the plant, instruments such as flow meters, electrical wiring, and paint. The total material and installation labor cost, also known as the total direct cost, is at the very bottom ($75,100). It is this number that is the most important. It is the number that you'll pay to have this piece of equipment magically appear in your chemical plant in working order. You'll see it also back in the main screen, middle column, by selecting the List tab at the bottom.

Similarly, add the remaining equipment, as shown in Figure 10.12: the condenser, reboiler, reflux drum, and distillation column. Use the specifications given in the figure, and leave anything else at their default values.

The trayed tower (DTW TRAYED) model should be used for distillation, which includes the trays but does not include the condenser, reboiler, or reflux pump. It is located at Process equipment | Towers, columns-trayed/packed | Tower-single diameter | Trayed tower. Change the Application to Distillation with kettle reboiler (DIS-RB). For the condenser, you can use a Pre-engineered U-tube exchanger (DHE PRE ENGR). It is located at Process equipment | Heat exchangers, heaters | Heat exchanger | Pre-engineered (standard) U-tube exchanger. The reflux drum is a vertical process vessel (DVT CYLINDER). It is located at Process equipment | Vessel-pressure, storage | Vesselvertical tank | Vertical process vessel. In this case "height" is "Tangent to tangent height." For the reboiler, use "Kettle type reboiler with floating head" (DRB KETTLE). It is located at Process equipment | Heat exchangers, heaters | Reboiler | Kettle type reboiler with floating head.


Distillation Column
29 Sieve Trays made of
304 Stainless Steel
3.5ft Diameter.
18" Tray Spacing
Reboiler
Kettle Type
2500 ft2 heating
surface area
Condenser
Pre-engineered U-Tube
290 tubes, 12ft full extension
0.75 inch outer diameter
Reflux Drum
3 ft diameter
5 ft height
(vertical tank)
Reflux Pump
Centrifugal
130 gallons per minute
450 feet of fluid head
195 psig design pressure
Vapor Overhead
Feed
Distillate
Product
Liquid
Reflux
Bottoms
Product

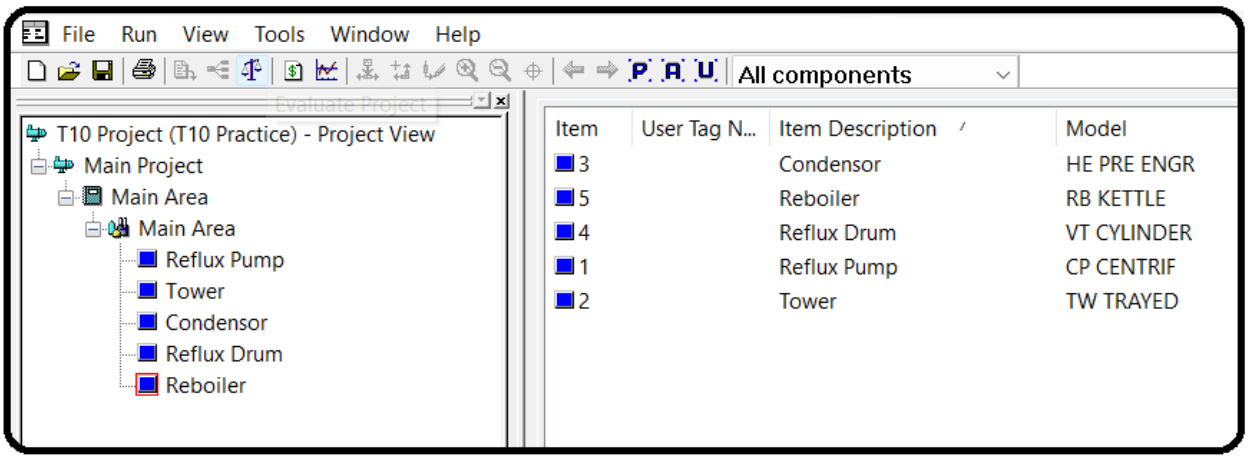
Name	Units	Item 1
Remarks 2		
Item description		Tower
User tag number		
Drawing reference number		
Structure tag		
Component WBS		
Quoted cost per item	CAD	
Currency unit for matl cost		
Source of quote		
Number of identical items		1
Installation option		
Code of account		
Icarus/User COA option		
Tray type		SIEVE
Application		DIS-RB
Shell material		
Vessel diameter	FEET	3.5
Vessel tangent to tangent height	FEET	
Design gauge pressure	PSIG	15
Vacuum design gauge pressure	PSIG	
Design temperature	DEG F	
Operating temperature	DEG F	
Tray material		SS304
Number of trays		29
Tray spacing	INCHES	18
Demister thickness	INCHES	
Cladding material		NONE
Skirt height	FEET	
Skirt thickness	INCHES	
Wind or seismic design		
Fluid volume	PERCENT	20
Manhole diameter	INCHES	
Number of manholes		
Base material thickness	INCHES	
Corrosion allowance	INCHES	
Number of body flange sets	PAIR	
Weld efficiency	PERCENT	
Stress relief		
Cladding thickness	INCHES	
Stiffening ring spacing	INCHES	
Number of platforms		

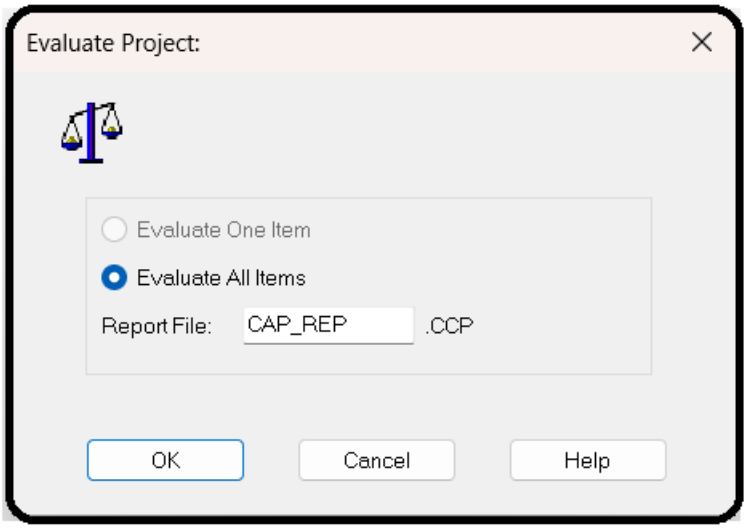
Name	Units	Item 1
Item Reference Number		3
Remarks 1		
Remarks 2		
Item description		Condensor
User tag number		
Drawing reference number		
Structure tag		
Component WBS		
Quoted cost per item	CAD	
Currency unit for matl cost		
Source of quote		
Number of identical items		1
Installation option		
Code of account		
Icarus/User COA option		
Heat transfer area	SF	
Tube material		CA443
Tube design gauge pressure	PSIG	150
Tube design temperature	DEG F	250
Tube operating temperature	DEG F	
Tube outside diameter	INCHES	0.75
Shell material		A285C
Shell design gauge pressure	PSIG	150
Shell design temperature	DEG F	250
Shell operating temperature	DEG F	
Number of tubes		290
Tube length extended	FEET	12
Tube gauge	BWG	
Tube wall thickness	INCHES	
Tube corrosion allowance	INCHES	
Tube pitch	INCHES	
Tube pitch symbol		TRIANGULAR
Shell diameter	INCHES	
Shell wall thickness	INCHES	
Shell corrosion allowance	INCHES	
Saddle height	INCHES	10
Equipment Footprint X	FEET	
Equipment Footprint Y	FEET	
Equipment Footprint Z	FEET	
Equipment Coordinate X	FEET	

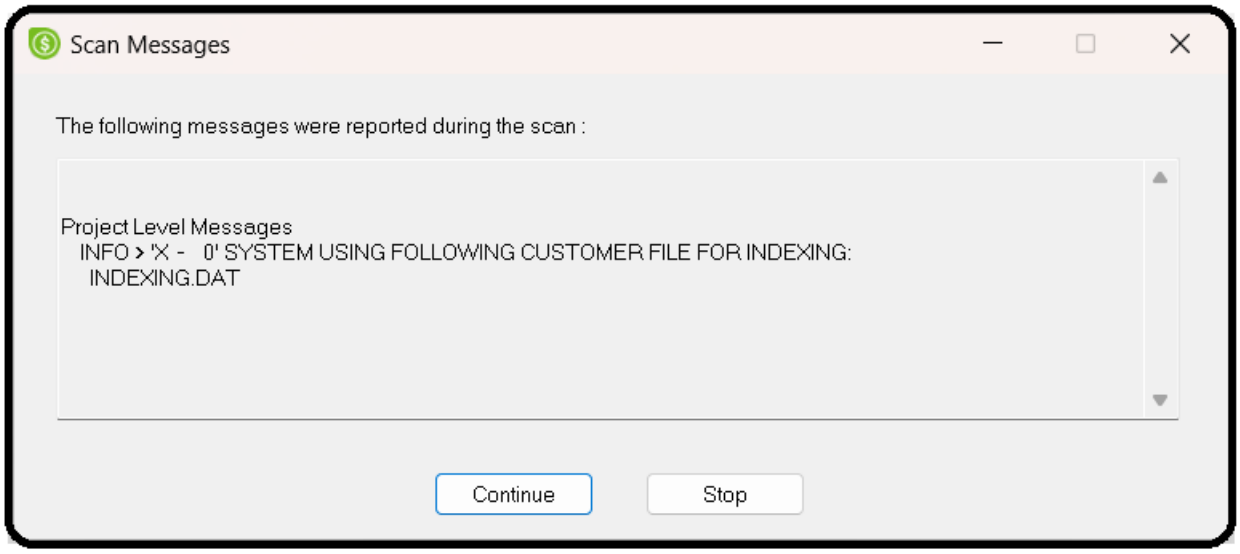
Name	Units	Item 1
Item Reference Number		4
Remarks 1		
Remarks 2		
Item description		Reflux Drum
User tag number		
Drawing reference number		
Structure tag		
Component WBS		
Quoted cost per item	CAD	
Currency unit for matl cost		
Source of quote		
Number of identical items		1
Installation option		
Code of account		
Icarus/User COA option		
Application		CONT
Shell material		
Liquid volume	GALLONS	
Vessel diameter	FEET	3
Vessel tangent to tangent height	FEET	5
Design gauge pressure	PSIG	15
Vacuum design gauge pressure	PSIG	
Design temperature	DEG F	
Operating temperature	DEG F	
Skirt height	FEET	
Skirt thickness	INCHES	
Vessel leg height	FEET	
Wind or seismic design		
Fluid volume	PERCENT	20
Manhole diameter	INCHES	18
Number of manholes		1
Allowance for internals	PERCENT	0
Demister thickness	INCHES	
Demister area	SF	
Base material thickness	INCHES	
Corrosion allowance	INCHES	
Number of body flange sets	PAIR	
Weld efficiency	PERCENT	
Stress relief		
Cladding material		

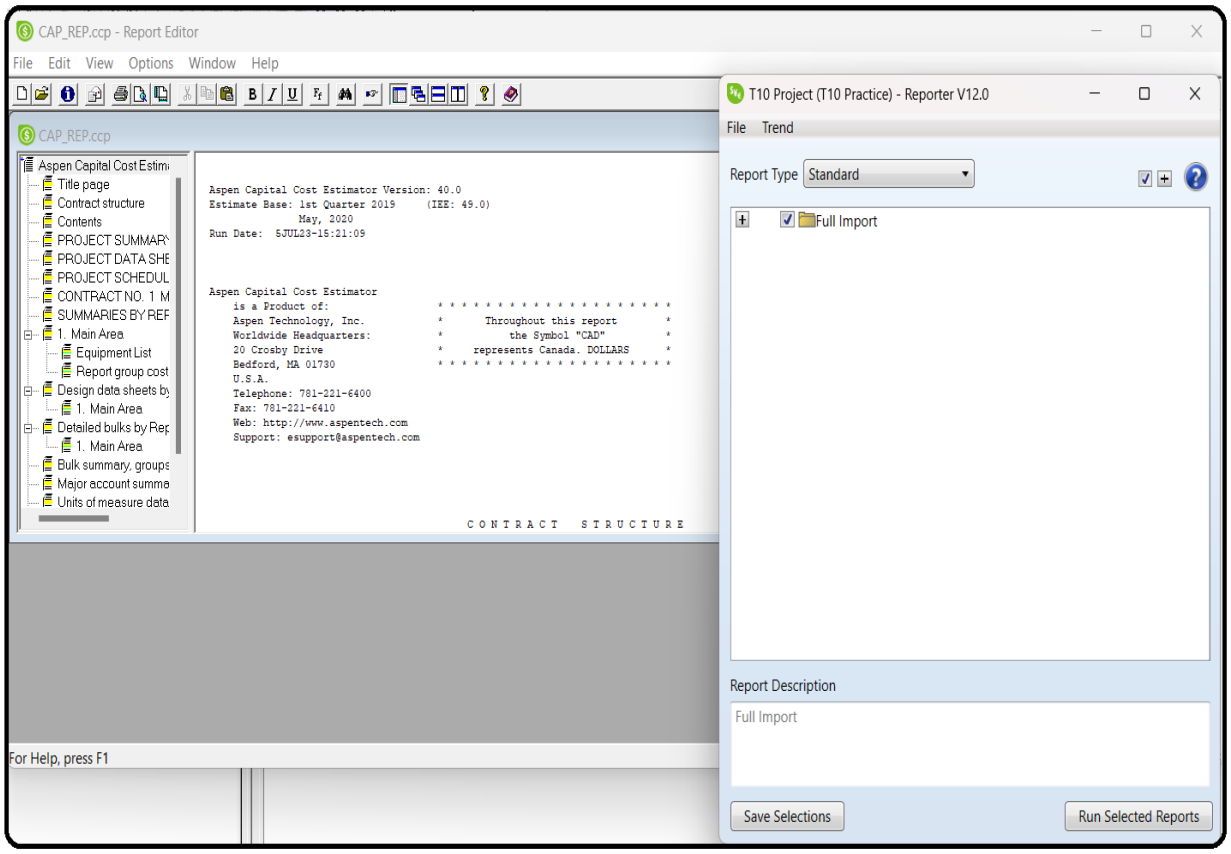
Name	Units	Item 1
Item Reference Number		5
Remarks 1		
Remarks 2		
Item description		Reboiler
User tag number		
Drawing reference number		
Structure tag		
Component WBS		
Quoted cost per item	CAD	
Currency unit for matl cost		
Source of quote		
Number of identical items		1
Installation option		
Code of account		
Icarus/User COA option		
Heat transfer area	SF	2,500
Number of shells		
Tube material		
Heat exchanger design option		
Tube design gauge pressure	PSIG	150
Tube design temperature	DEG F	
Tube operating temperature	DEG F	
Tube outside diameter	INCHES	1
Shell material		
Shell design gauge pressure	PSIG	150
Shell design temperature	DEG F	
Shell operating temperature	DEG F	
Tube side pipe material		
Shell side pipe material		
Number of tubes per shell		
Tube length extended	FEET	
Tube gauge	BWG	
Tube wall thickness	INCHES	
Tube corrosion allowance	INCHES	
Tube pitch	INCHES	
Tube pitch symbol		TRIANGULAR
Shell diameter	INCHES	
Tube port diameter	INCHES	
Shell wall thickness	INCHES	
Shell corrosion allowance	INCHES	
Tube sheet material		

Then, once the individual pieces of equipment are added, you can run an economic analysis for the whole plant which uses them. This includes labor, operations, utilities, maintenance, loans, taxes, inflation, and investments. We will not go into this now. We will do one more thing though. Let's look into the depth of the calculations. When you have finished adding the equipment, click the Evaluate Project button in the toolbar and select Evaluate All Items, and let it do its magic (create a report). Note that you'll get an error message. It's okay for now as we are not designing a real plant and didn't go into a lot of details. Just click continue for the Scan Messages window, and close for the Capital Cost Errors window. A new Report Editor window pops up in which Aspen gives you a suggested build-out plan for your plant containing this equipment (Mine is called CAP_REP.ccp—Report Editor). From the report we can see that Aspen is using vendor quotes from the first quarter of 2019, as shown in Figure 10.13.





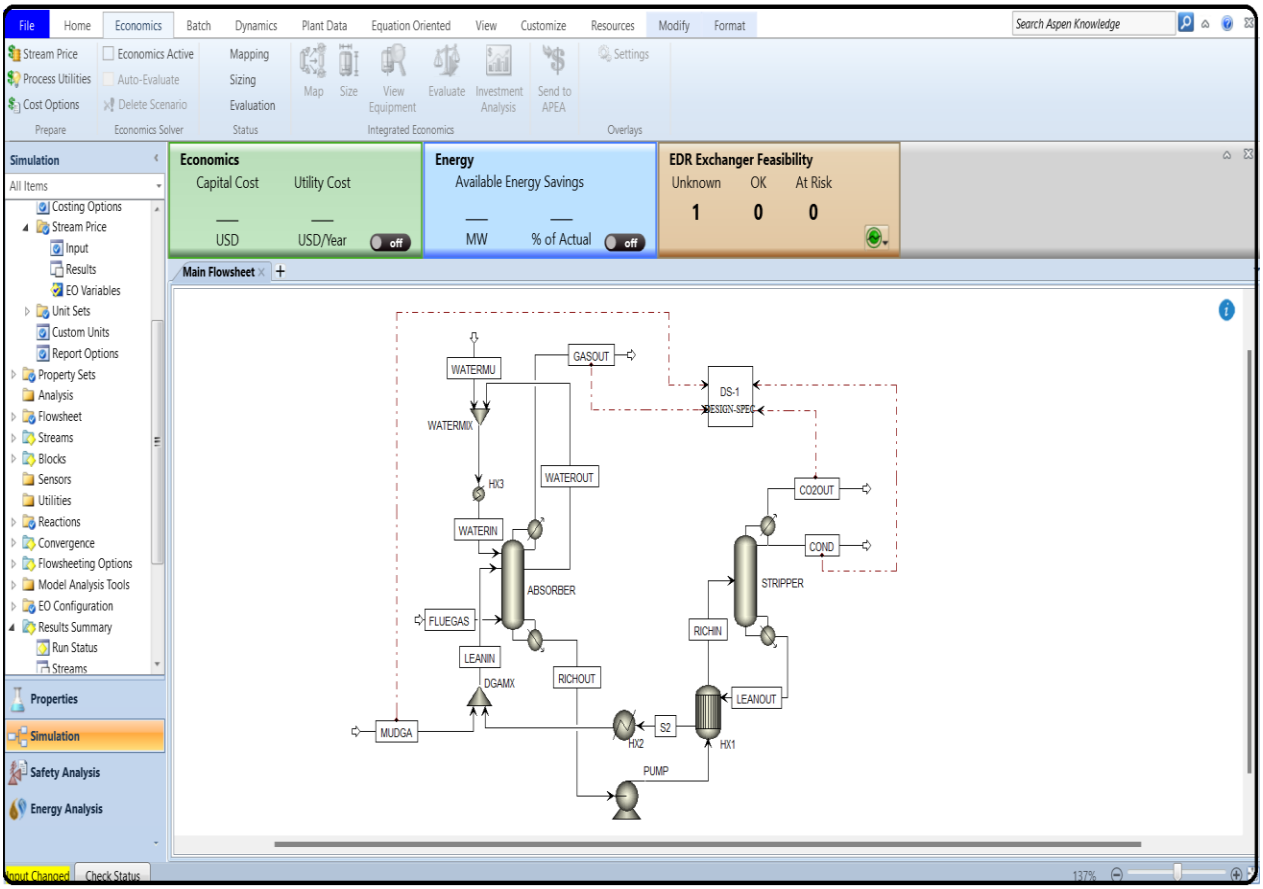

Scan Messages
The following messages were reported during the scan :
Project Level Messages
INFO > 'X - 0' SYSTEM USING FOLLOWING CUSTOMER FILE FOR INDEXING:
INDEXING.DAT
Continue
Stop


CAP_REP.ccp - Report Editor
File Edit View Options Window Help
CAP_REP.ccp
Aspen Capital Cost Estimator Version: 40.0
Estimate Base: 1st Quarter 2019 (IEE: 49.0)
May, 2020
Run Date: 5JUL23-15:21:09
Aspen Capital Cost Estimator
is a Product of:
Aspen Technology, Inc.
Worldwide Headquarters:
20 Crosby Drive
Bedford, MA 01730
U.S.A.
Telephone: 781-221-6400
Fax: 781-221-6410
Web: http://www.aspentech.com
Support: esupport@aspentech.com
Throughout this report
the Symbol "CAD"
represents Canada. DOLLARS
CONTRACT STRUCTURE
T10 Project (T10 Practice) - Reporter V12.0
File Trend
Report Type Standard
Full Import
Report Description
Full Import
Save Selections
Run Selected Reports
For Help, press F1

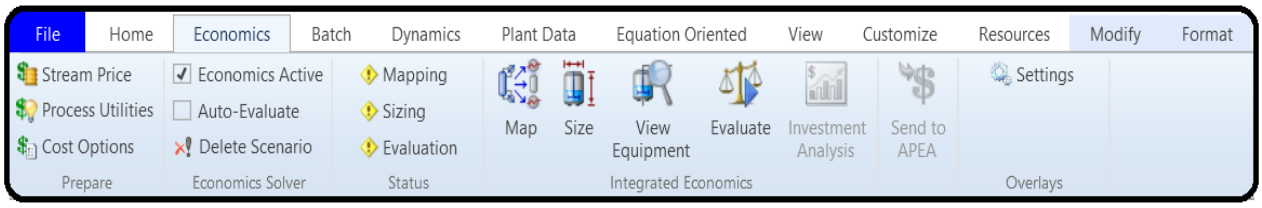
Part 2:

Performing Costing

Run the simulation. You must start with a converged simulation to perform costing. Then Activate costing. This starts APEA in the background.
Next, you must Map the Aspen Plus unit operation models into equipment models. In this step, Aspen Process Economic Analyzer loads data from Aspen Plus and generates a default mapping for each unit operation model to models of equipment whose cost can be estimated. This mapping may not be one-to-one; in particular, complex models such as distillation columns may be modeled as multiple pieces of equipment. Next, you must Size the equipment, determining appropriate sizes for the equipment based on data from the unit operation models and streams in Aspen Plus. Finally, you must Evaluate the model to determine costs for each piece of equipment.

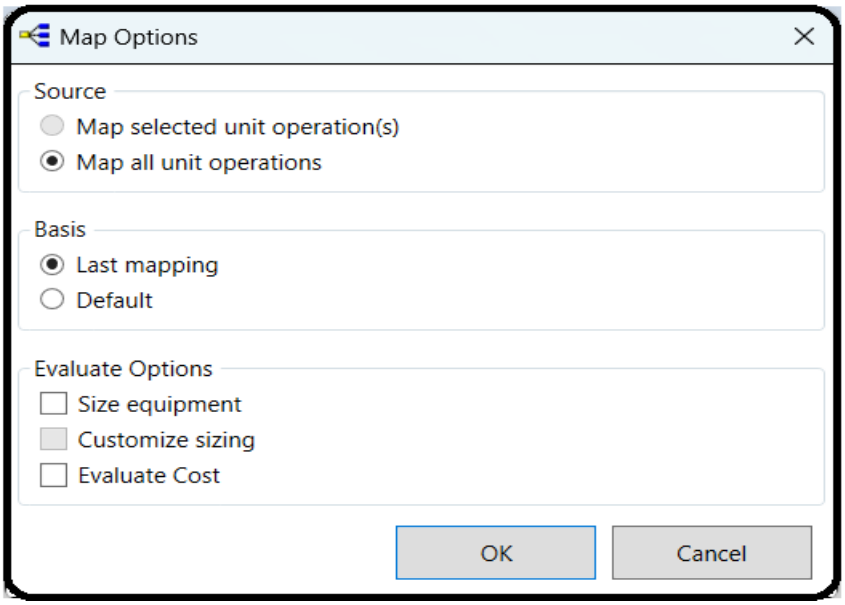


Next in ribbon/Economics, check Economic Active like below:



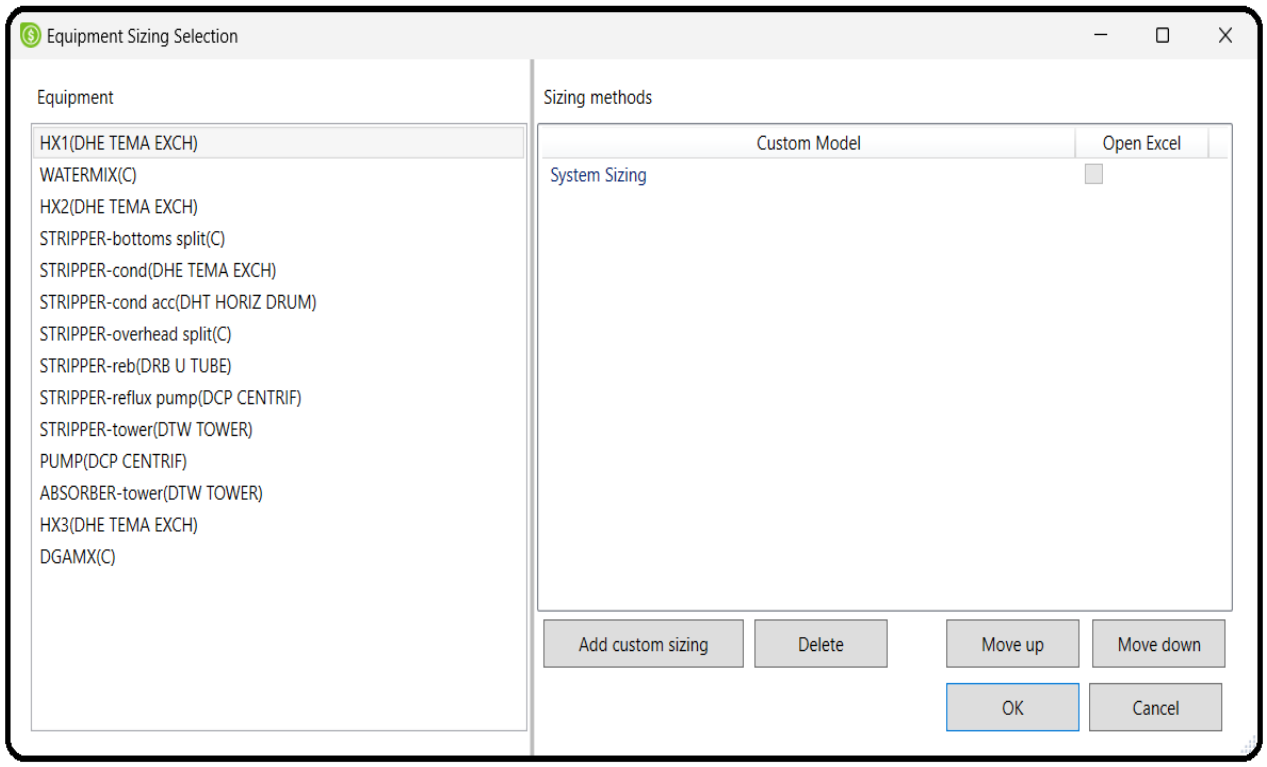
When you click on Mapping the following pops up, proceed like below, so that everything is done manually.

Mapping is the process of associating an equipment model in Aspen Process Economic Analyzer with each.
Use the Map command in the Economics tab of the ribbon to view or modify the mapping of unit operation models from the simulation into equipment models from Aspen Process Economic Analyzer.
On the first screen, choose whether the basis should be the last mapping or the default mapping, and whether to size and evaluate automatically after mapping.
After you click OK, a second screen appears where you can adjust the mapping for each model. On the left, select a unit operation from the flowsheet. In the top right section, select the equipment model to map this unit operation into. Some unit operations map into more than one piece of equipment, and some have multiple configurations you can select in the bottom right section. For some models, diagrams of the different configurations are displayed which you can click on to see a larger version in a separate window. You can also click Add to add additional mappings or Delete to delete a selected mapping.



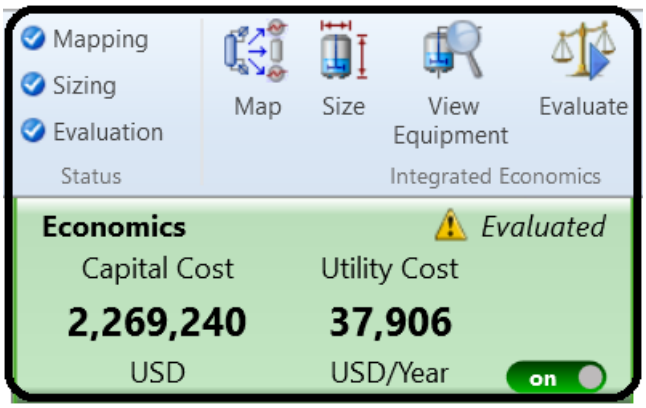
Now click Sizing:

Use the Size command in the Economics tab of the ribbon to have Aspen Process Economic Analyzer estimate the sizes required for equipment based on the simulation data provided. If equipment mapping has not been performed when this command is used, it will be done with the default mappings.
You can also size individual equipment items of certain types interactively.



Now click Evaluate:

Use the Evaluate command in the Economics tab of the ribbon to have Aspen Process Economic Analyzer estimate the cost of your plant based on the data provided from the simulation. The results of this calculation are available in the Cost Grid.
If sizing has not been formed when this command is used, it will be performed before evaluating.
If equipment mapping has not been performed when this command is used, it will be done with the default mappings.



The Status group on the **Economics** tab of the ribbon displays three status indicators:

1.Mapping
2.Sizing
3.Evaluation

Each of these indicators can display these status icons:

Status	Meaning
(blank)	Economic analysis not started
	This part of the evaluation is being performed (or waiting for input, if performed interactively)
	This part of the evaluation completed
	This part of the evaluation has not been performed since the last input change (or it is due to be performed next, if performed interactively)
	This part of the evaluation did not complete due to an error in the APEA engine. This can occur if APEA crashes or be related to file corruption.

Now click on the Economics Ribbon and check the result:

Enabled by **Aspen Process Economic Analyzer (APEA)**

Template: <Default> | Save | Save as new | Reset | Paste | Send to Excel/ASW

Summary | **Utilities** | Unit operation | Equipment | TEMA HEX | Quoted equipment | Horizontal drum | U-tube reboiler | Centrif pump | Multi-diameter tower

Name	Fluid	Rate	Rate Units	Cost per Hour	Cost Units
Electricity		52.507	KW	4.06929	USD/H
Cooling Water	Water	9.6E-05	MMGAL/H	0.01152	USD/H
Refrigerant - Freon 12	Refrigerant	0.106012	KLB/H	0.009011	USD/H
Steam @100PSI	Steam	0.028793	KLB/H	0.234375	USD/H

Enabled by **Aspen Process Economic Analyzer (APEA)**

Template: <Default> | Save | Save as new | Reset | Paste | Send to Excel/ASW

Summary | Utilities | **Unit operation** | Equipment | TEMA HEX | Quoted equipment | Horizontal drum | U-tube reboiler | Centrif pump | Multi-diameter tower

Name	Equipment Cost [USD]	Installed Cost [USD]	Equipment Weight [LBS]	Installed Weight [LBS]	Utility Cost [USD/HR]
HX1	10,700	71,000	920	8110	0
WATERMIX	0	0	0	0	0
HX2	0	0	0	0	0.01104
STRIPPER	39,400	260,400	7600	23995	0.250361
PUMP	4,400	29,600	170	2201	0.006975
ABSORBER	0	0	0	0	0
HX3	0	0	0	0	0.00048
DGAMX	0	0	0	0	0

Interactive Sizing | Evaluate Selected | Enabled by **Aspen Process Economic Analyzer (APEA)**

Template: <Default> | Save | Save as new | Reset | Paste | Send to Excel/ASW

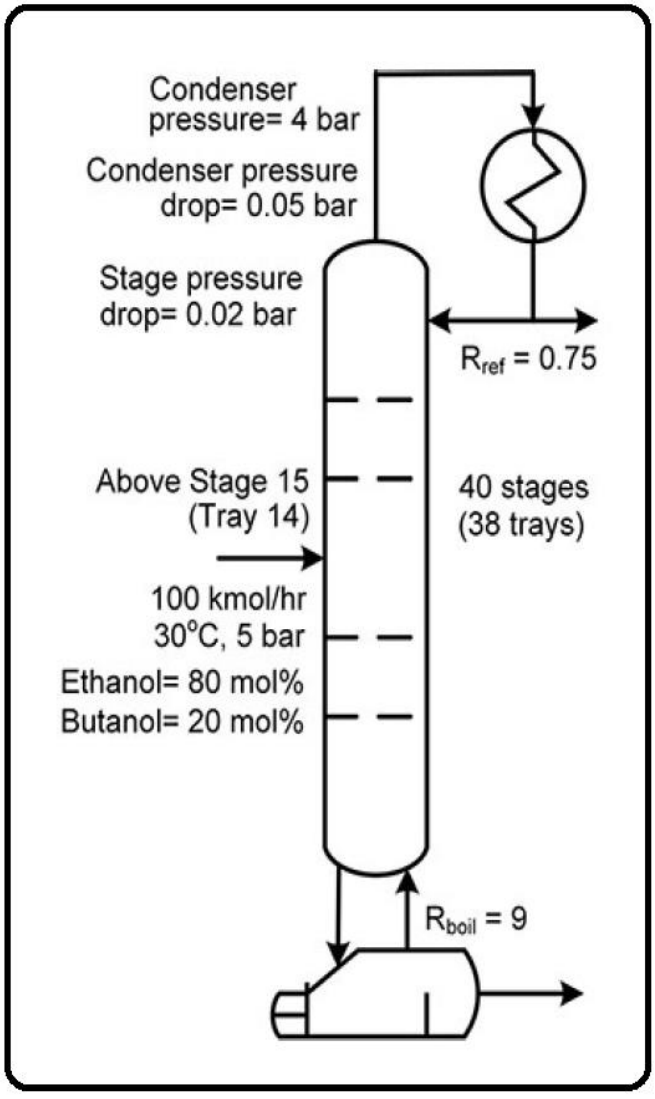
Summary | Utilities | Unit operation | Equipment | **TEMA HEX** | Quoted equipment | Horizontal drum | U-tube reboiler | Centrif pump | Multi-diameter tower

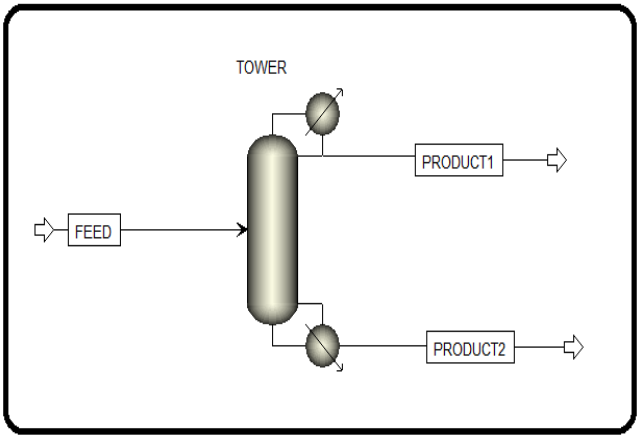
User tag number	HX1	HX2	STRIPPER-cond	HX3
Remarks 1	Equipment mapped	Equipment mapped	Equipment mapped	Equipment mapped
Quoted cost per item [USD]				
Currency unit for matl cost				
Number of identical items	1	1	1	1
Installation option				
Heat transfer area [sqm]	4.35428	0.140518	0.0432954	0.0106804
Number of shells				
Front end TEMA symbol	B	B	B	B
Shell TEMA symbol	E	E	E	E
Rear end TEMA symbol	M	M	M	M
Heat exchanger design option				
Tube material				
Tube design gauge pressure [N/sqm-gauge]	243421	415796	243421	415796

Part 3 :

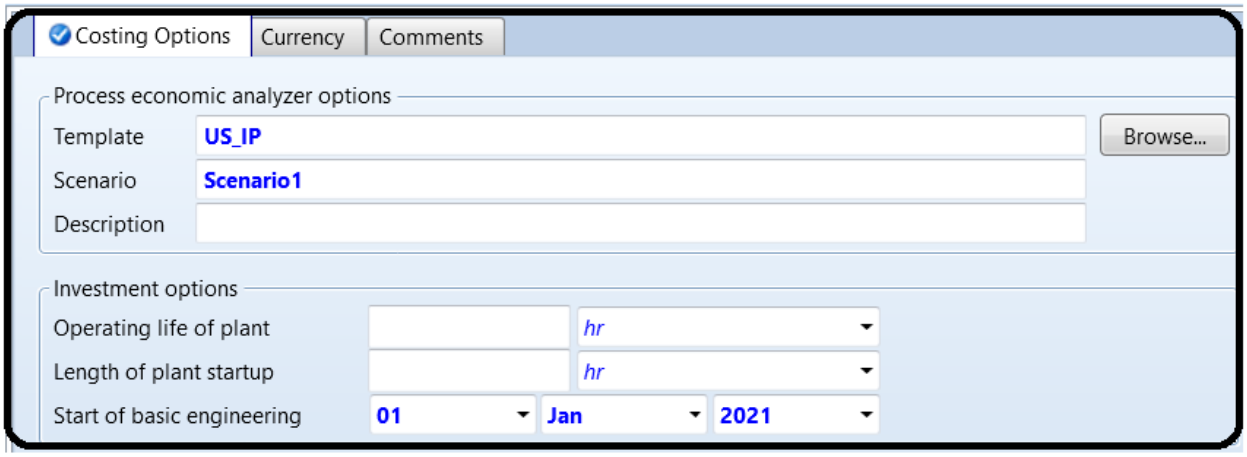
INTEGRATED ECONOMICS IN ASPEN PLUS

Capital cost estimates can be directly integrated with Aspen Plus V12 in two ways. You can either export an Aspen Plus flowsheet into Aspen Capital Cost Estimator, or you can have capital costs predicted right in Aspen Plus itself. We will do the latter briefly here. Figure 10.14 shows a very simple distillation of an 80/20 mixture of ethanol and butanol using an ordinary distillation column. Simulate the column in Aspen Plus using a RadFrac model for the distillation column and NRTL-RK for the property method. Run the simulation first and ensure that it converges correctly.

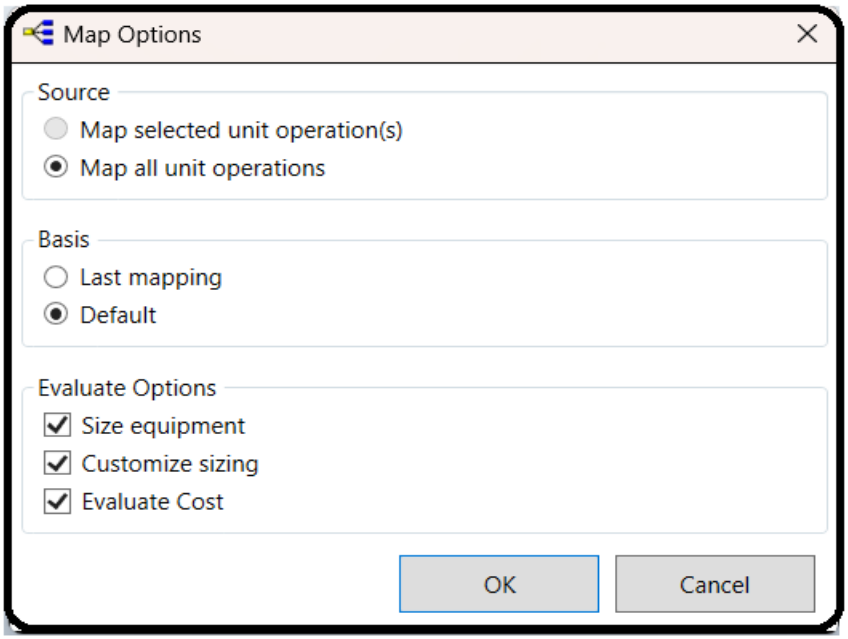




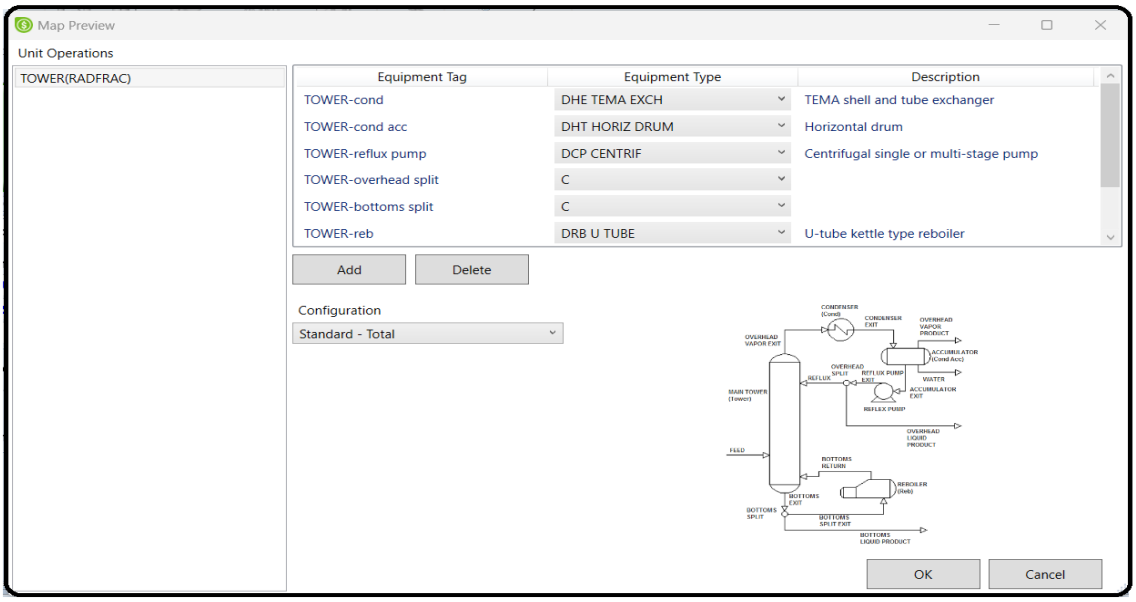
Now let's make the Economics Active. If you haven't yet, go to the Economics ribbon and check the box for Economics Active (see Figure 10.15). Then, go to the Cost Options button on the ribbon (or Simulation | Setup | Costing Options). You'll see that you can enter in some of the basics that you could in Aspen Capital Cost Estimator. So go ahead and change the start of basic engineering to January 1, 2021. Although you have the ability to enter a currency symbol and conversion rate on the Currency tab, it does not get considered in the economic analysis. It will only work in USD (by default) while inside Aspen Plus, or you can select one of the other built-in templates (European Union, Japan, China, the United Kingdom, or the Middle East) by changing the template on the Costing Options tab. To use currencies outside of those options, you should use the stand-alone Aspen Capital Cost Estimator application instead or make the conversion from USD to your units after the fact.

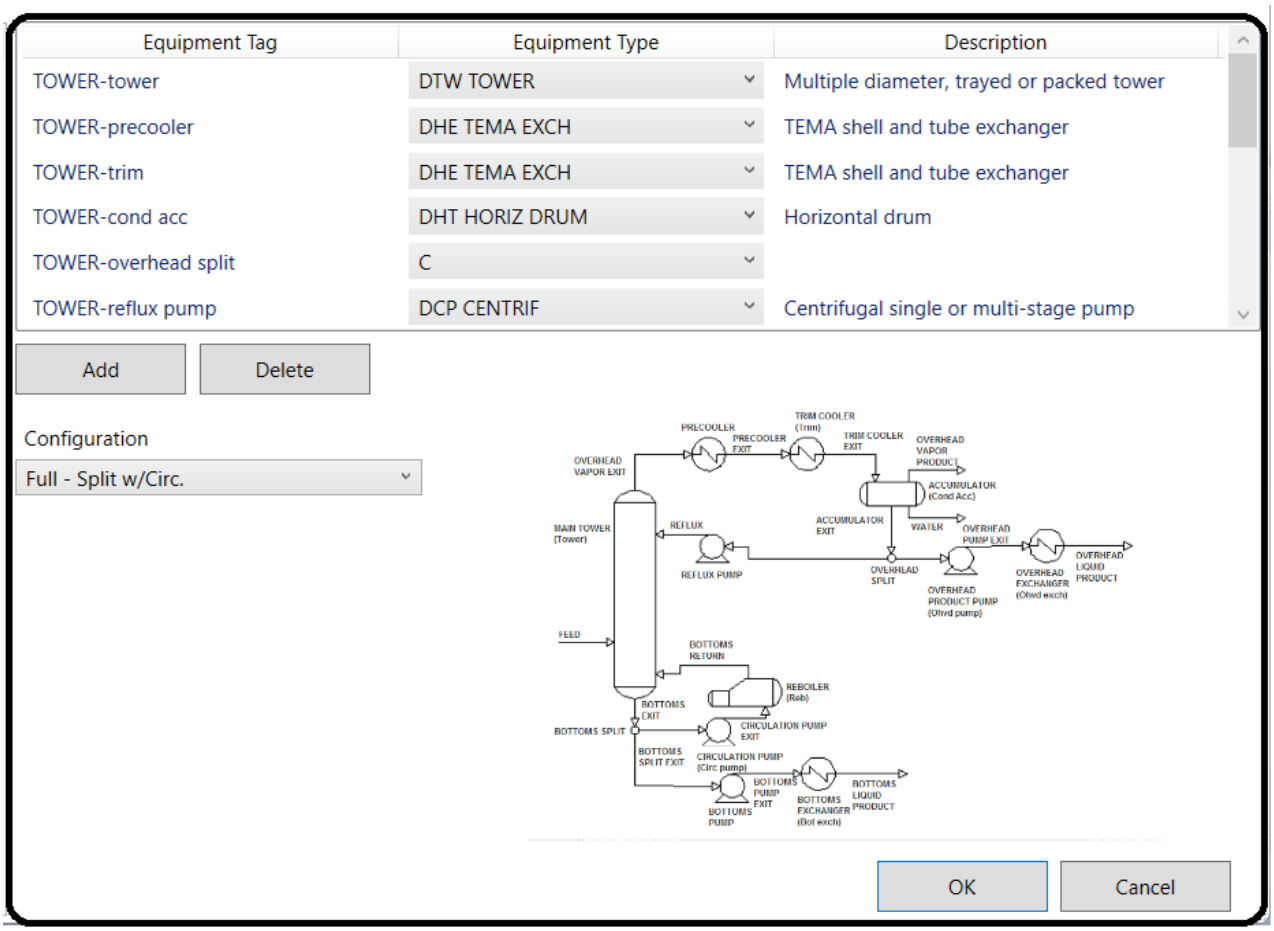


At this point, we need to map our simulation models to actual pieces of equipment. For example, our RadFrac model is just a set of equations which can represent many things (adsorption, distillation, extraction, rectification, stripping), so you have to map the simulation equations to a physical piece of equipment (or multiple pieces in this case) in the database. So click Map in the Economics ribbon (you may need to rerun the simulation first). You'll get a Map Options prompt (see Figure 10.16). In this case, you want to use the Default basis, and you want to size the equipment and evaluate the cost. Sizing the equipment is an important step; it means that your simulation results are used to compute the sizes of the equipment (e.g., the length and diameter of the reflux drum of the distillation column).

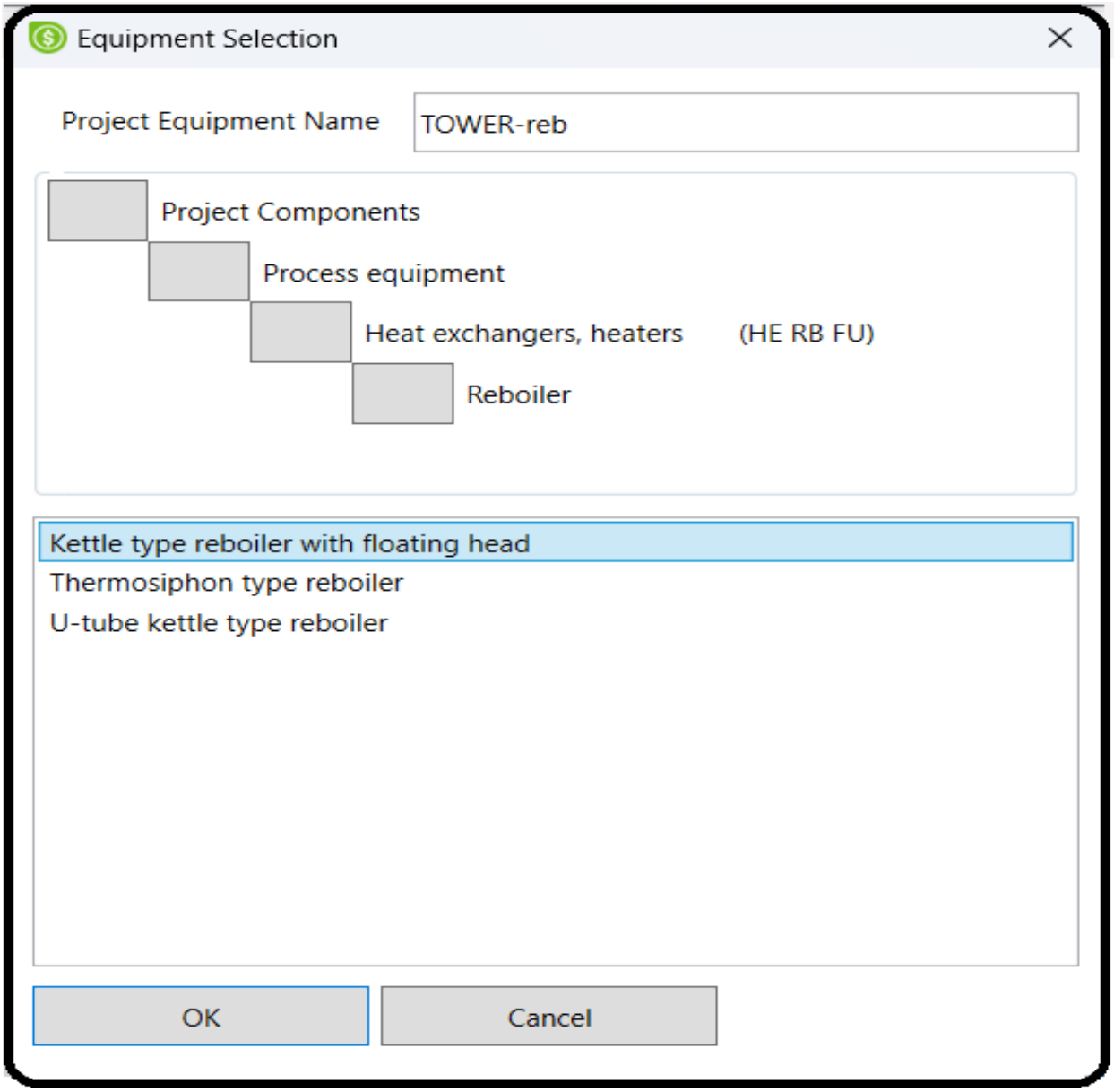


You should see that Aspen Plus maps the column and supporting equipment collectively modeled in the RadFrac block to a Trayed Column (DTW TOWER), a condenser (DHE TEMA EXCH), a horizontal drum (DHT HORIZ DRUM), a centrifugal pump (DCP CENTRIF), two splitters (C), and a reboiler (DRB U TUBE). This is the result of the Standard configuration chosen by default (i.e., choosing the Default basis on the Map Options form). Switch to the Full – Split w/Circ. configuration.

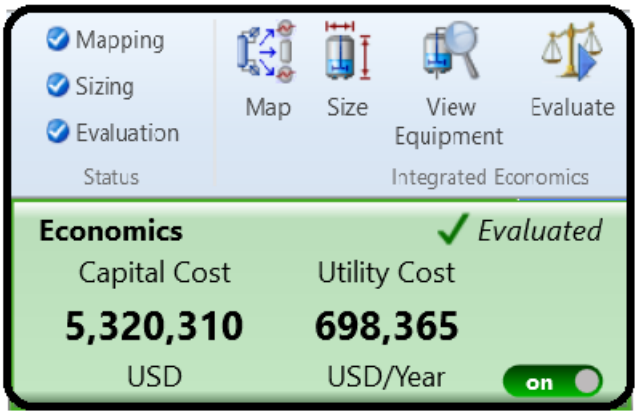




The mapping should then change to include more pumps, pre-coolers, etc. Let's change the reboiler to a different model. Select the DRB U TUBE item and change it to DRB KETTLE (Kettle type reboiler w/floating head) by selecting from the list, like was done in Part 1 (see Figure 10.17).

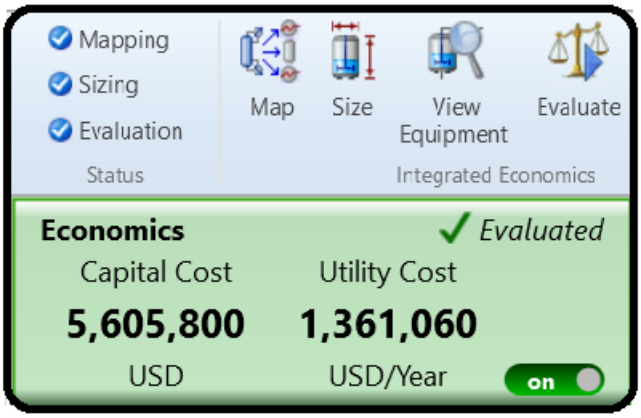


When you are done, click OK on the map preview page. You might get another prompt about custom sizing, if you checked that box by accident. Just leave it and click OK. You should see some familiar prompts. If it works then you should see the items checked in the ribbon, shown in Figure 10.18.



Let's see the results! Hit View Equipment in the Economics ribbon. Explore the tabs, see what it comes up with and answer the following questions. Note that the Sizing step takes your simulation results and then does more calculations to determine how these translate into physical dimensions, heights, widths, etc.

Rerun the simulation using an inlet flow rate of 200 kmol/hr instead of 100 (doubling the capacity of the system). Then, when that is finished, hit Size in the Economics ribbon to resize everything and be sure to reevaluate the cost as well. Keep the "last mapping," which means that your reboiler configuration change from DRB U TUBE to DRB KETTLE is remembered from when you did it last time. Confirm that the Full – Split w/Circ. configuration option is still selected (if it isn't, reselect it).



References:

1.Our team experience

2. Learn Aspen Plus in 24 hr. by Thomas A. Adams II

3.Aspen build-in help

4.Aspen build-in templates