Learn How to Optimize Heat Exchanger Designs using Aspen Shell & Tube Exchanger

A self guided demo to get started with Aspen Shell & Tube Exchanger

aspentech

Why use Aspen Shell & Tube Exchanger?

Aspen Shell & Tube Exchanger can be used to design all major industrial shell & tube exchanger equipment types in any combination of processes, including single phase heating or cooling and boiling or condensation. Typically, users save between 10-30% on equipment costs by effectively designing their exchangers using Aspen Exchanger Design & Rating.

Given a process requirement and physical property data, the program conducts a comprehensive design search to find the optimum cost arrangement capable of satisfying the process constraints. The program provides detailed exchanger geometry and performance details, as well as a specification sheet, setting plan, and tube layout drawings.

Completed designs can be transferred to Aspen Shell & Tube Mechanical for complete mechanical design to the requirements of ASME or other leading international design codes.

Objective

This tutorial is intended as “getting started” guide using Aspen Shell & Tube Exchanger to create, evaluate, and save designs. It offers a step-by-step explanation of how an equipment designer would use the standalone program.

The workflow is demonstrated by completing the design of a Shell & Tube exchanger for a crude preheat train process.

Specify Process and Property Data

Process and property data can be entered in three ways:

1. Manually
2. By using the physical property databanks provided within the program
3. By importing from a simulation case

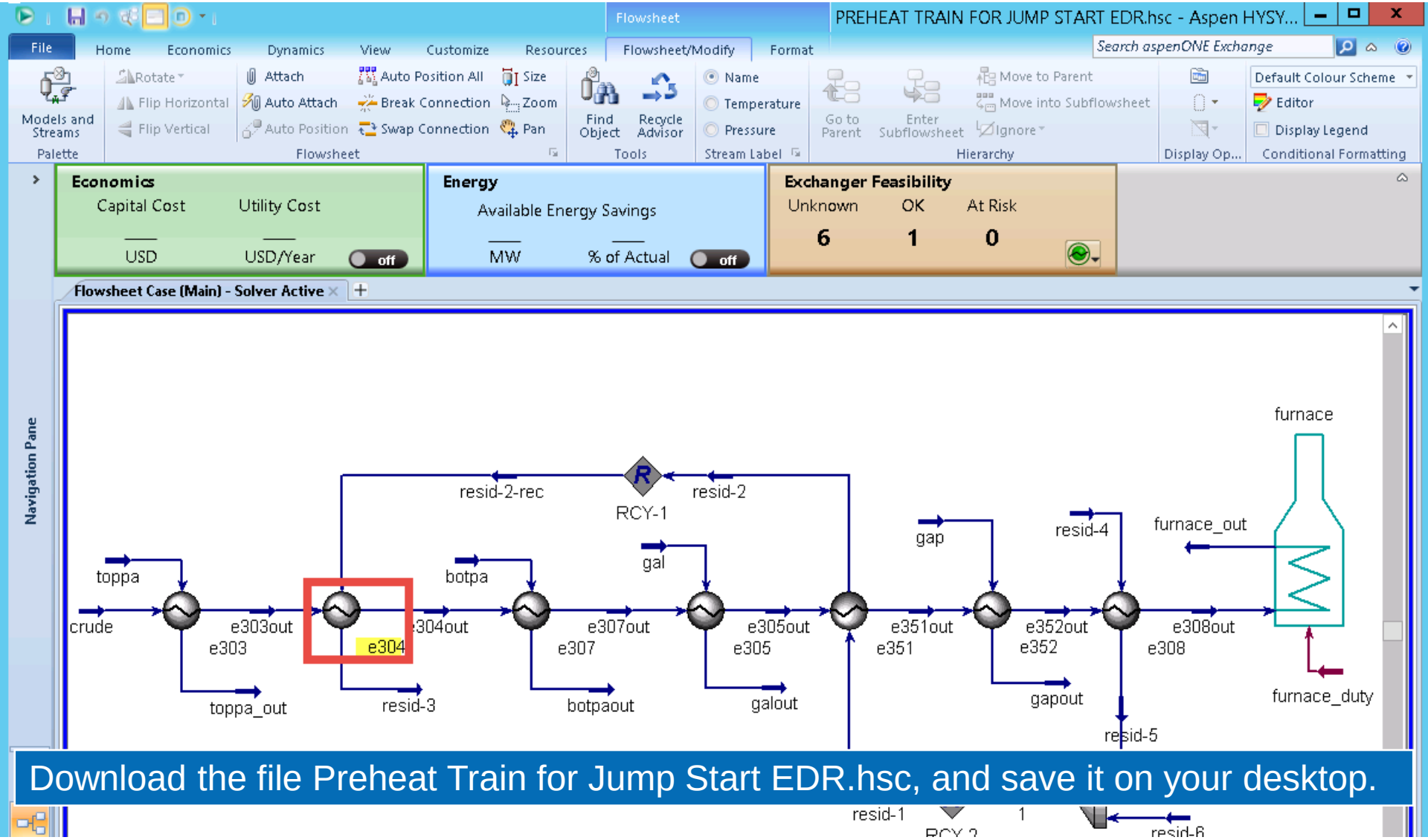
TUTORIAL I - we will import data from an Aspen HYSYS case file

TUTORIAL II - we will enter process and property data manually

To download the required files for this exercise please visit Aspen Tech's Customer Support Site. (Refer to Knowledge Base Solution ID: 143029 at the following location http://support.aspentech.com/webteamasp/KB.asp?ID=143029)

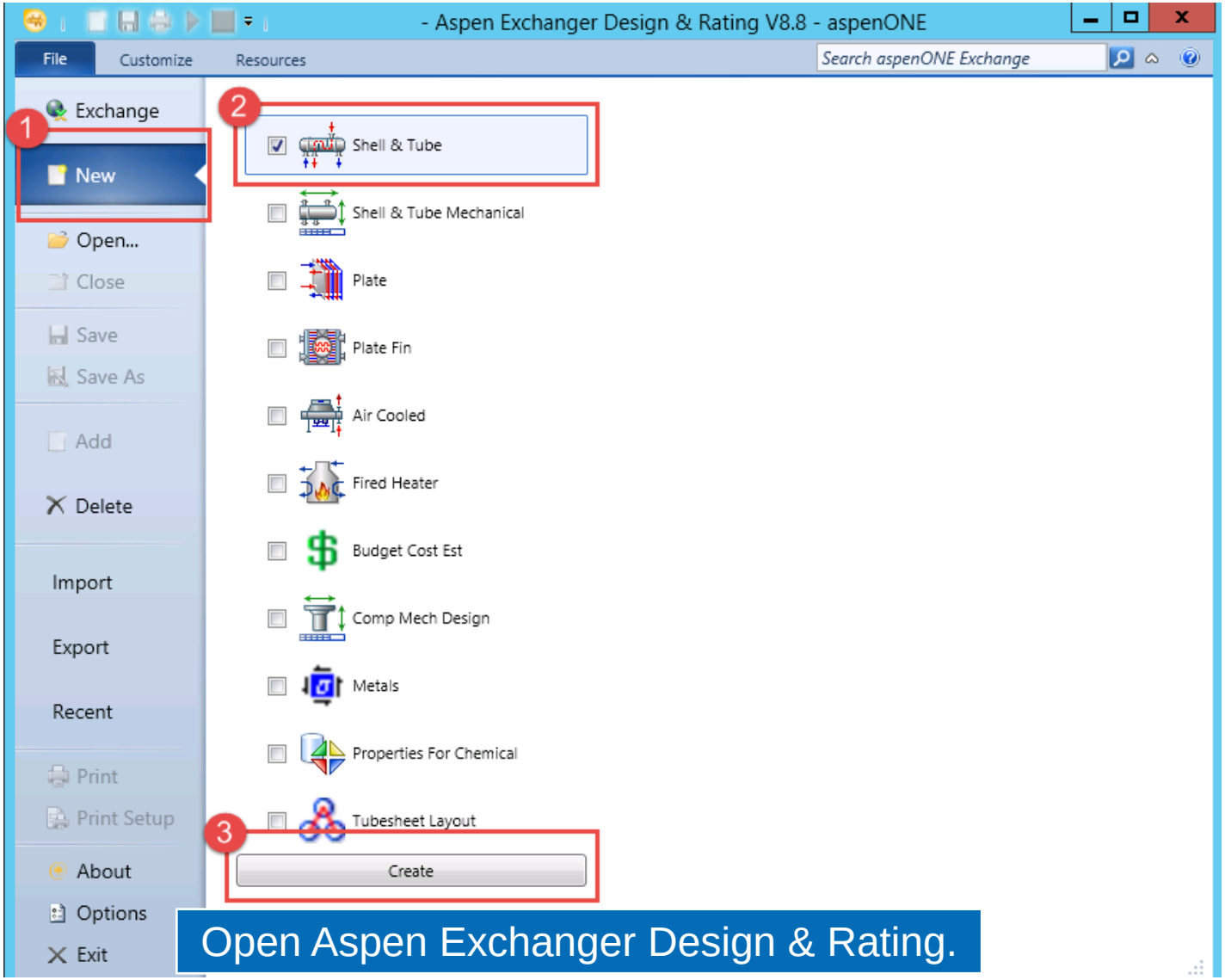
Tutorial I

Download & Save Aspen HYSYS® File

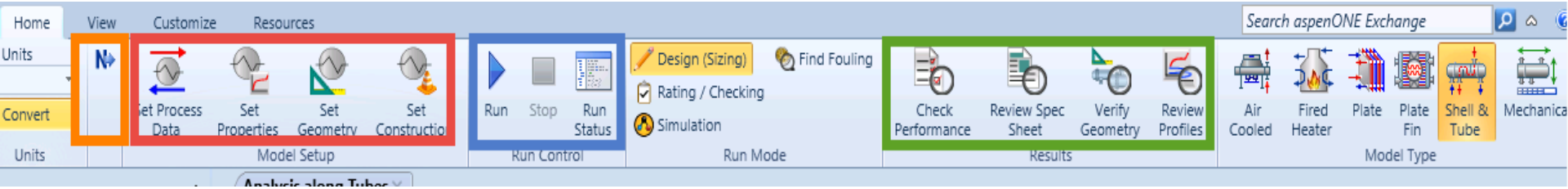


aspentech

Open Aspen Shell & Tube Exchanger



Home Ribbon Work Flow



‘HOME RIBBON” commands are used to guide us sequentially through the various stages of the heat exchanger design

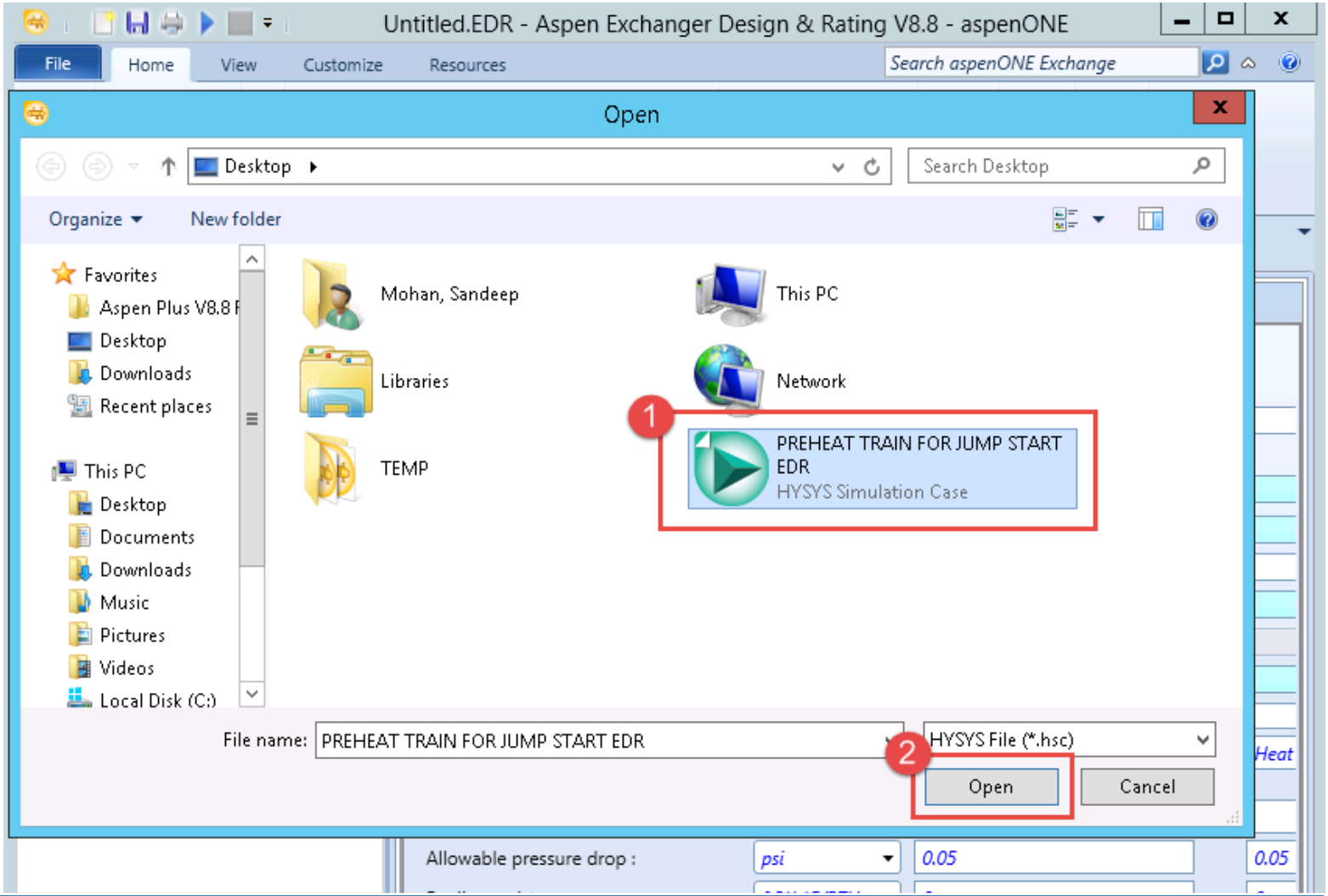
NEXT button guides us sequentially through the required input forms to complete the input for the problem.

MODEL SETUP contains commands to the main input forms.

RUN CONTROL contains key to run the design calculations.

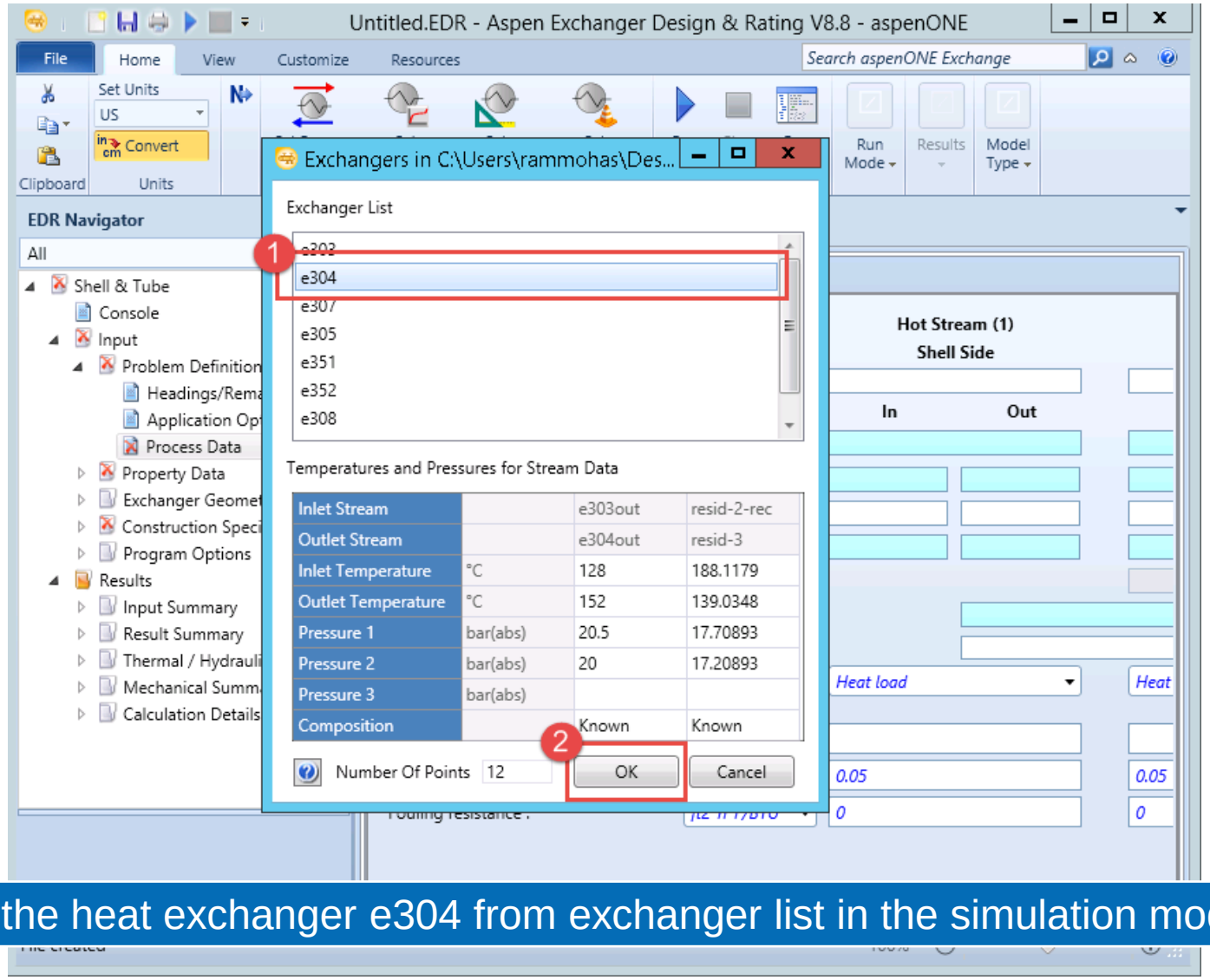
RESULTS contains commands to the key results forms.

Import Process & Property Data from Aspen HYSYS



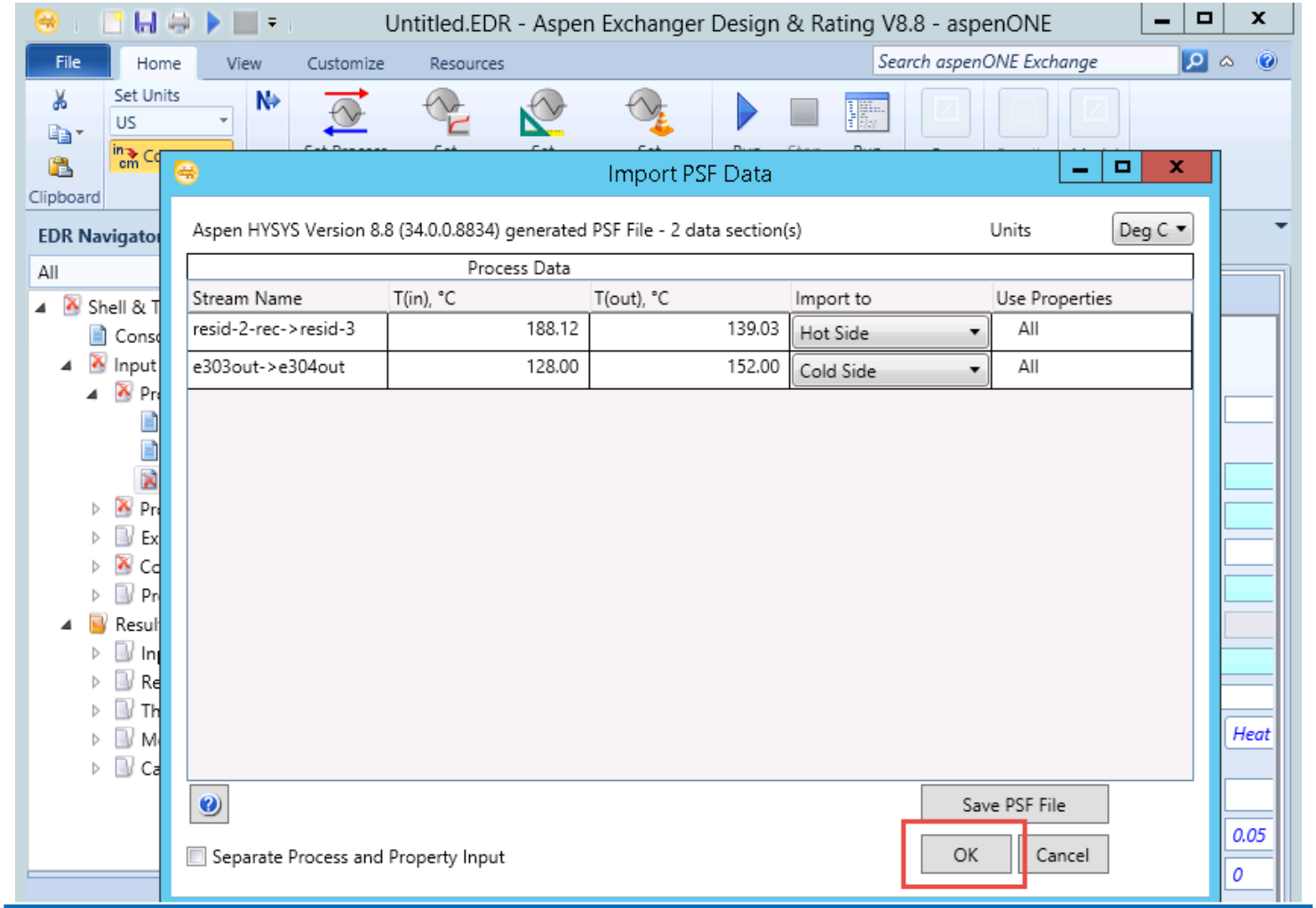
Click on File-Import and select ‘Preheat Train for Jump Start EDR. hsc’.

Select the Heat Exchanger from Aspen HYSYS Flowsheet



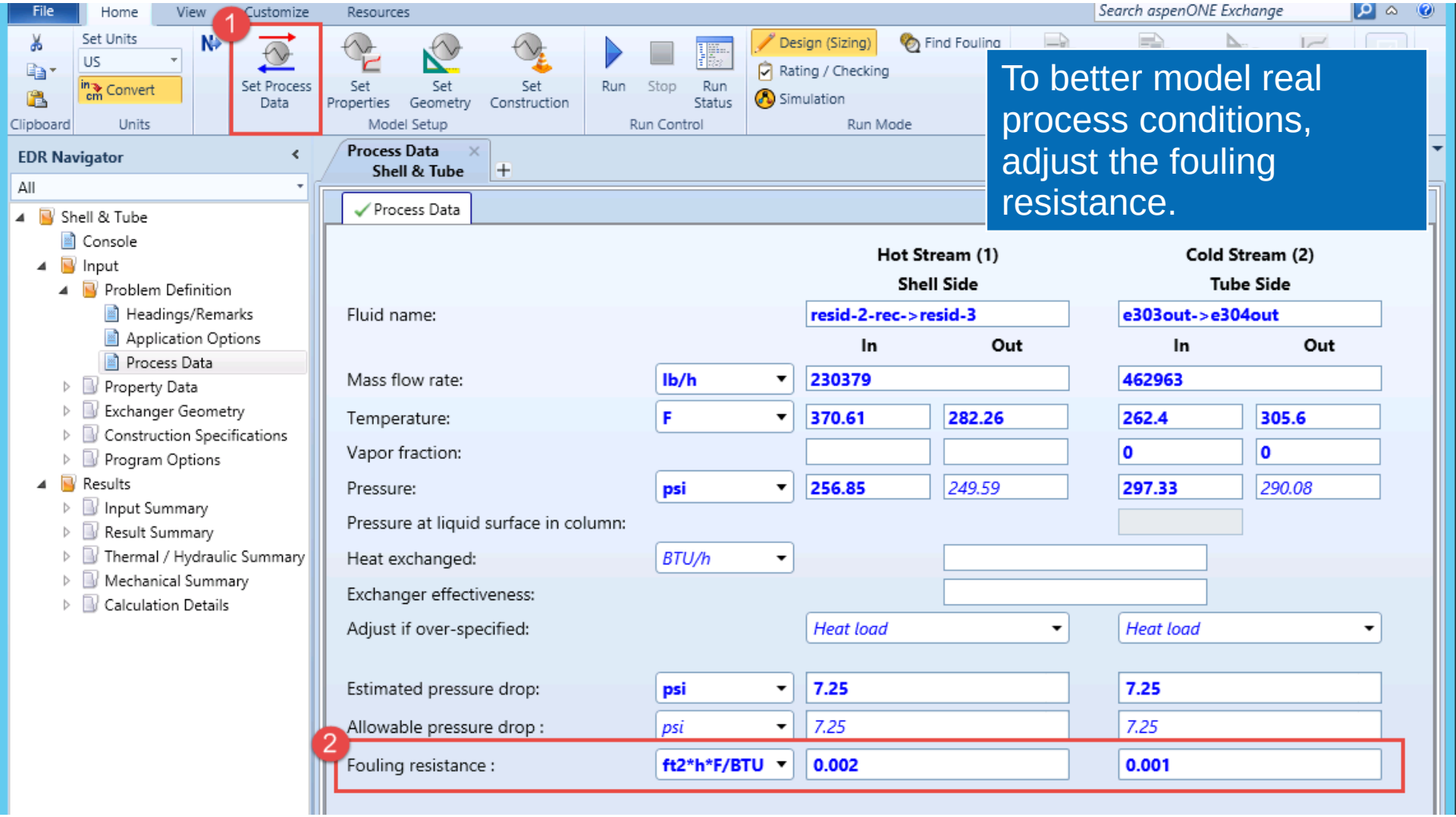
Select the heat exchanger e304 from exchanger list in the simulation model.

Import PSF Data



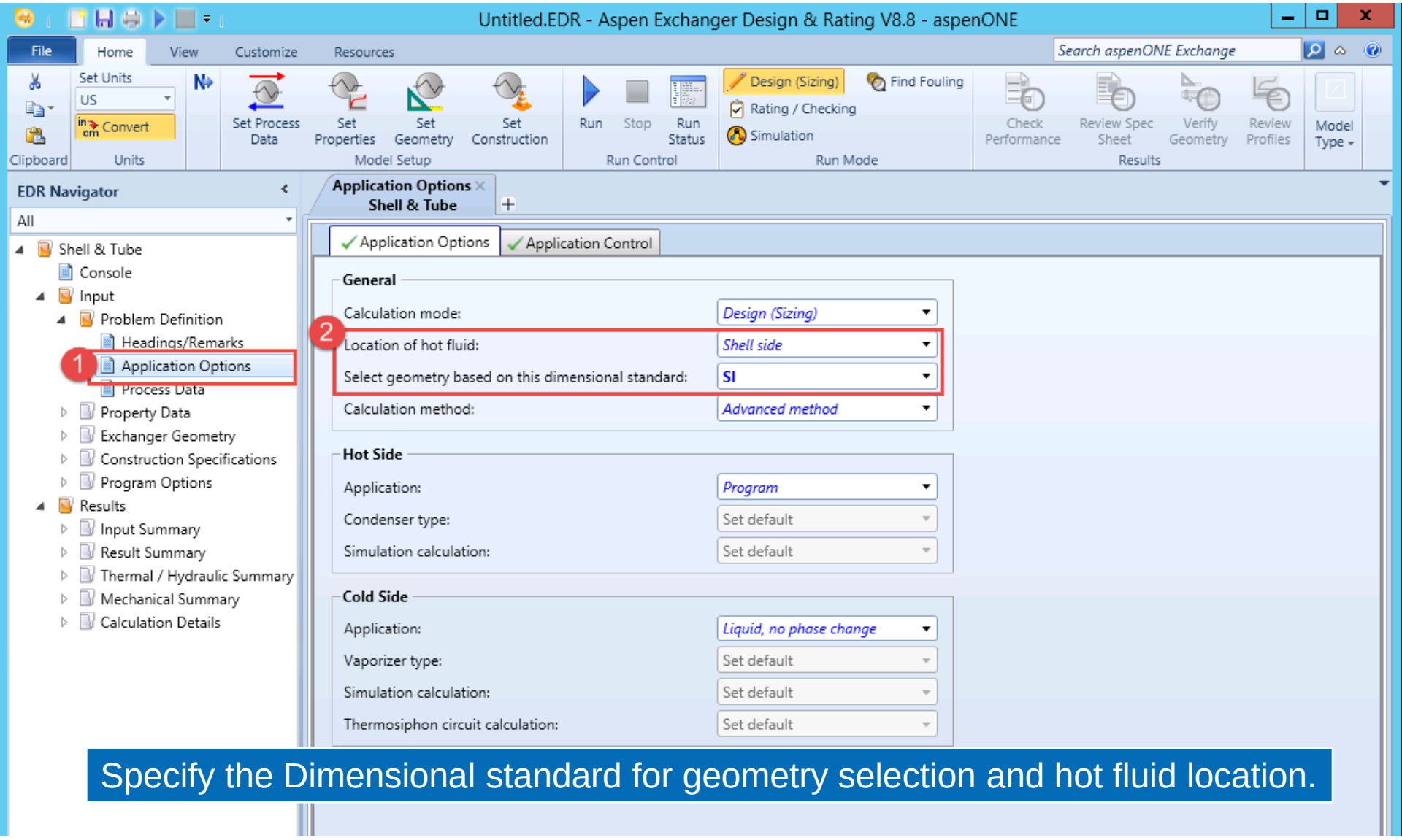
Click OK to Import Data from Process Simulator Interface File(PSF).

Specify Fouling Resistance



aspentech

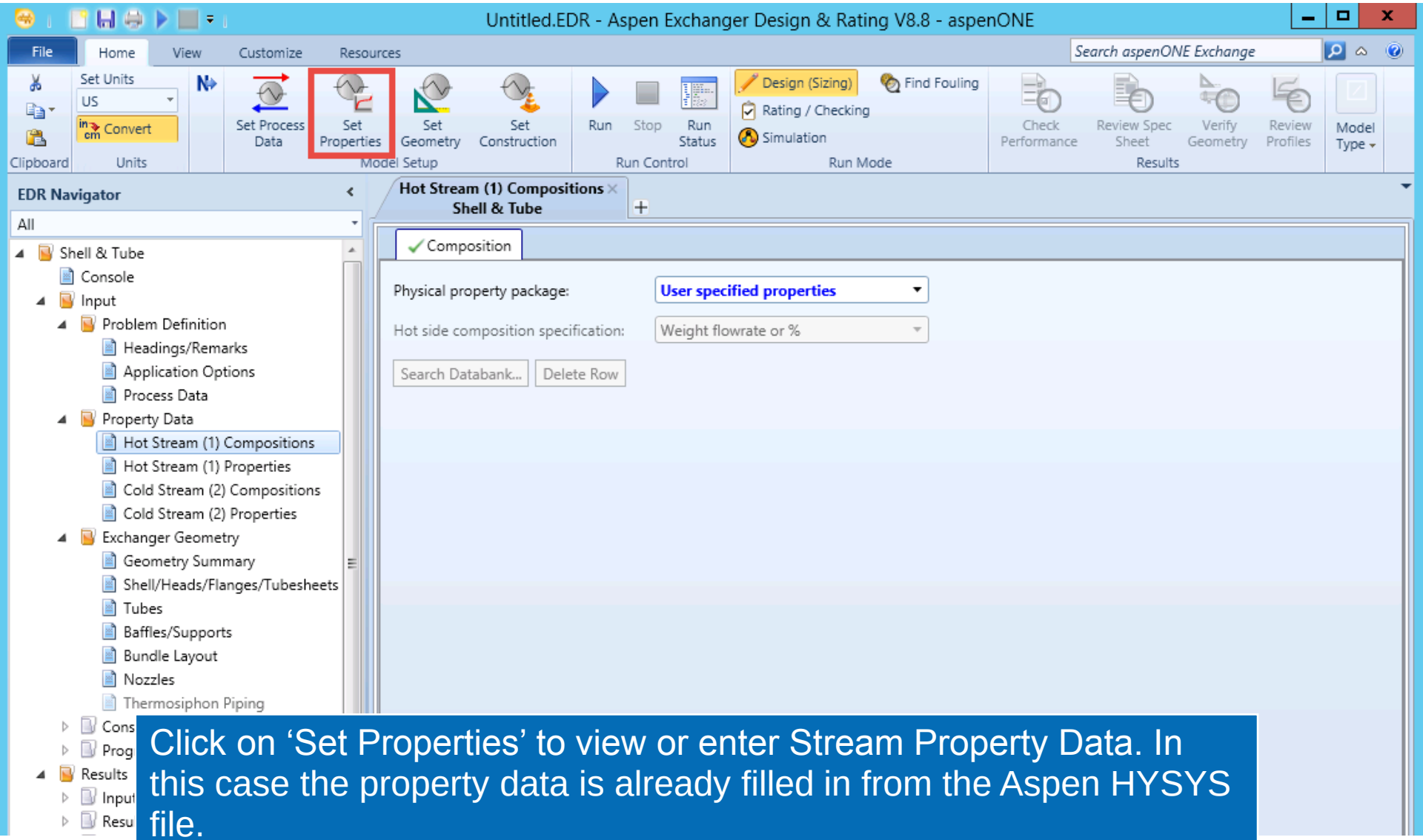
Select Dimensional Standards



Specify the Dimensional standard for geometry selection and hot fluid location.

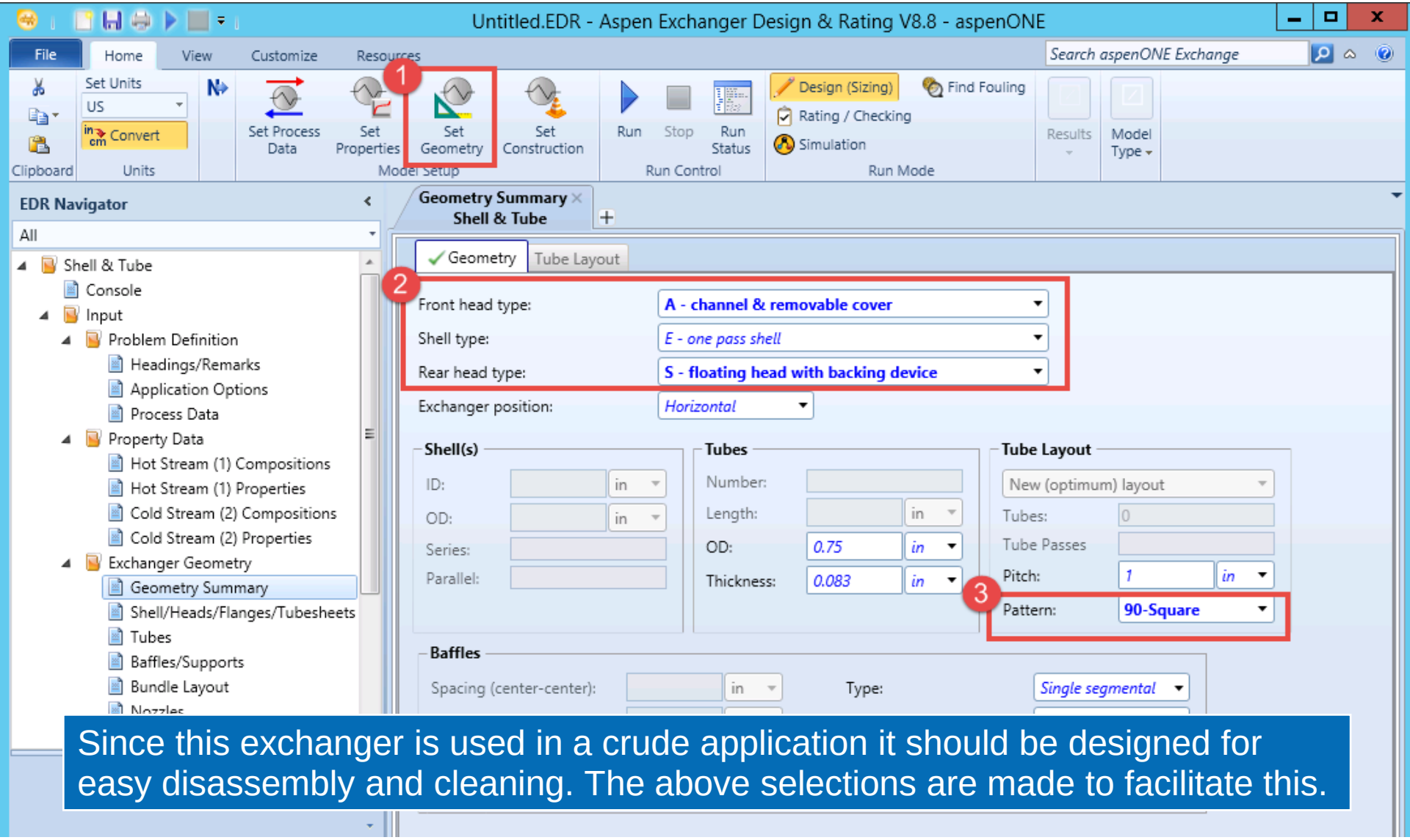
aspentech

View Property Data



Click on ‘Set Properties’ to view or enter Stream Property Data. In this case the property data is already filled in from the Aspen HYSYS file.

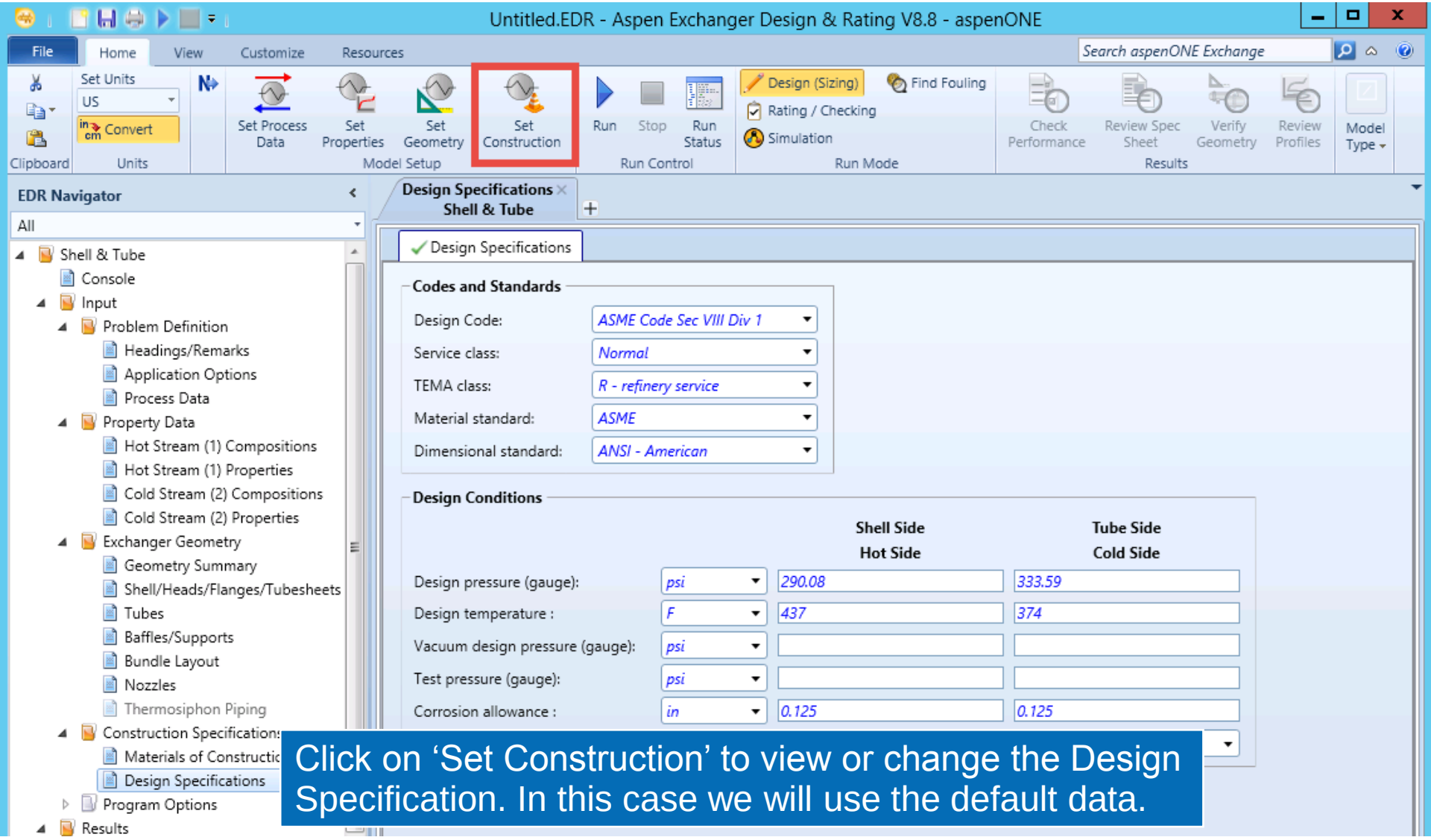
Set the Heat Exchanger Geometry



Since this exchanger is used in a crude application it should be designed for easy disassembly and cleaning. The above selections are made to facilitate this.

aspentech

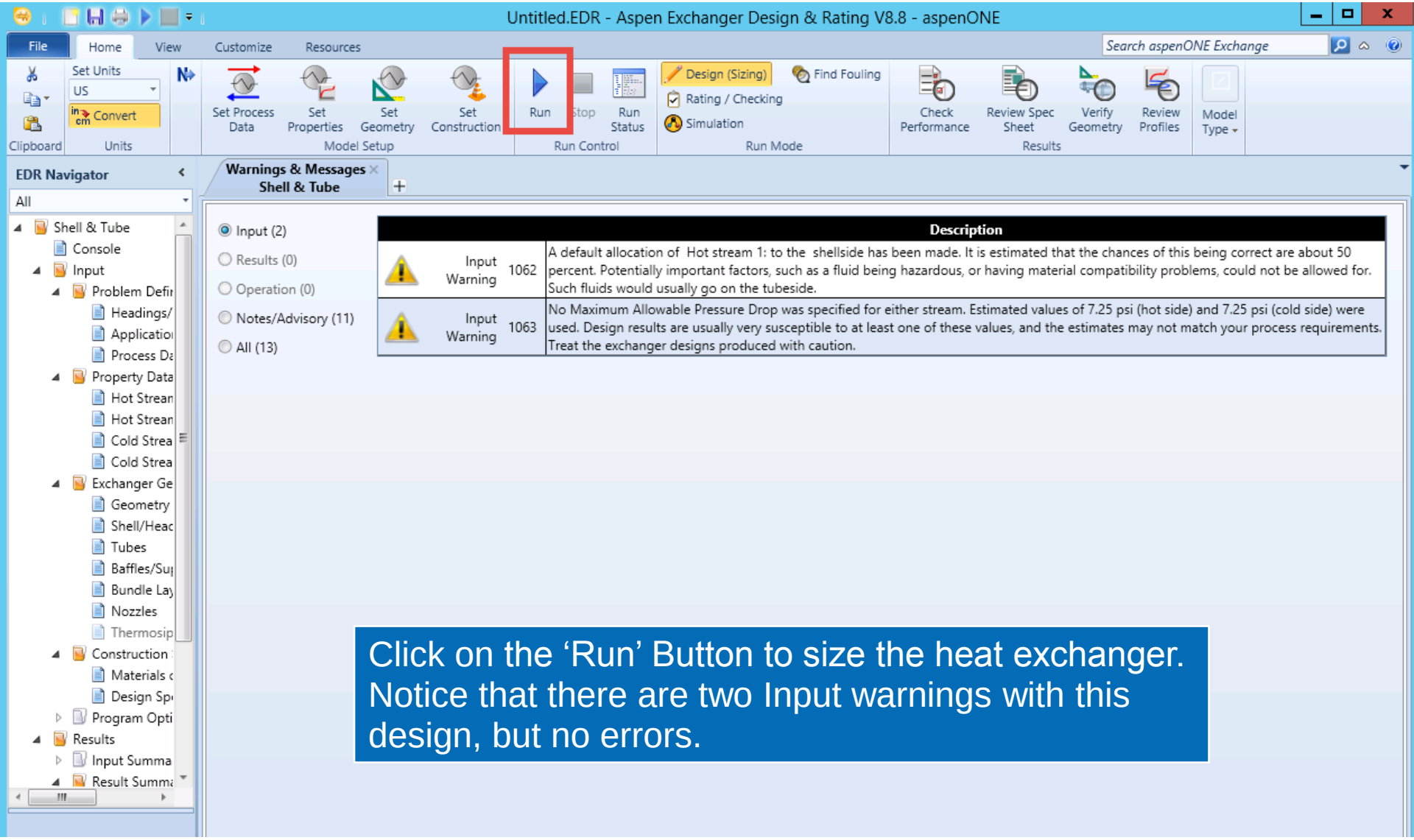
View Design Specification



Click on ‘Set Construction’ to view or change the Design Specification. In this case we will use the default data.

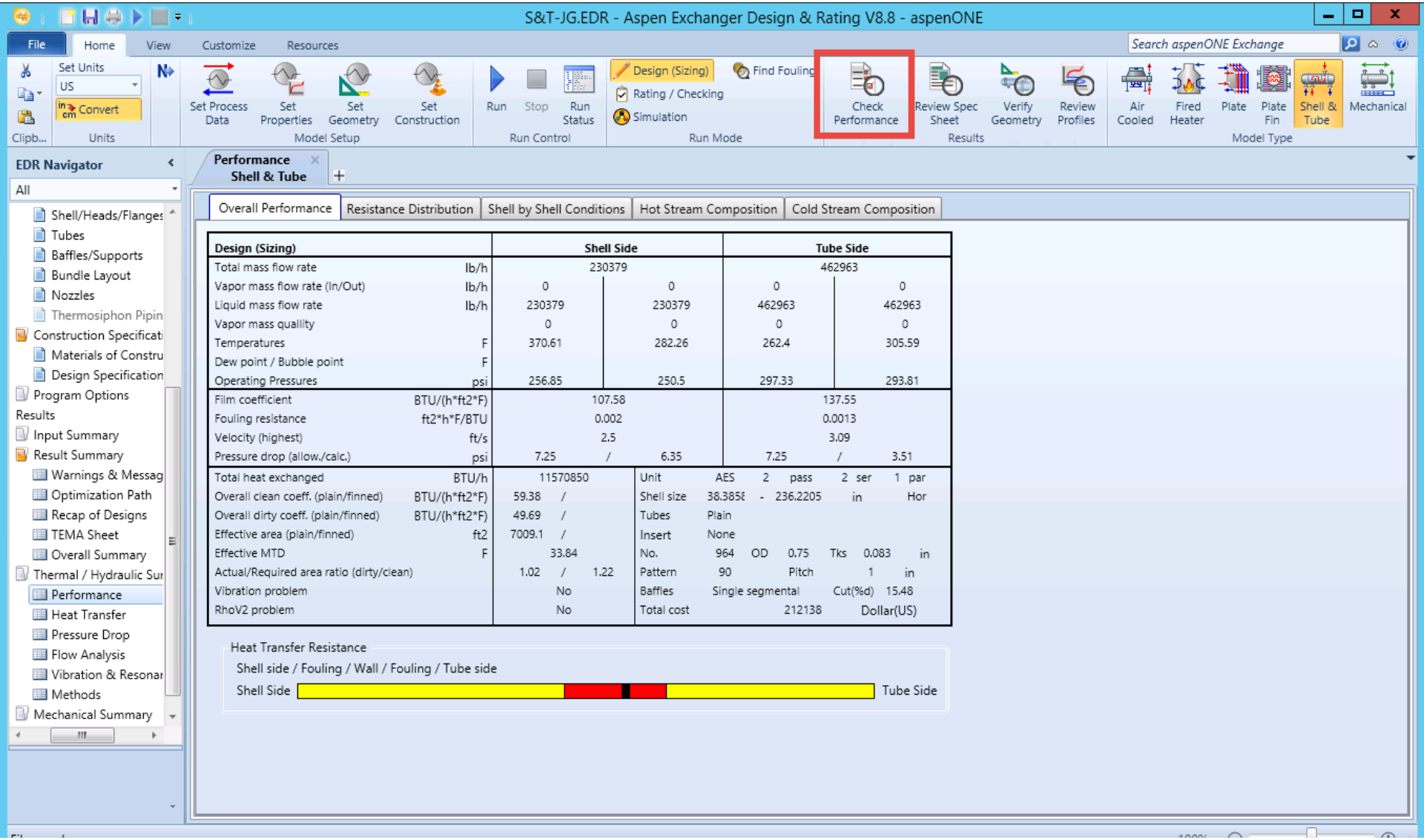
aspentech

Run Sizing Optimization



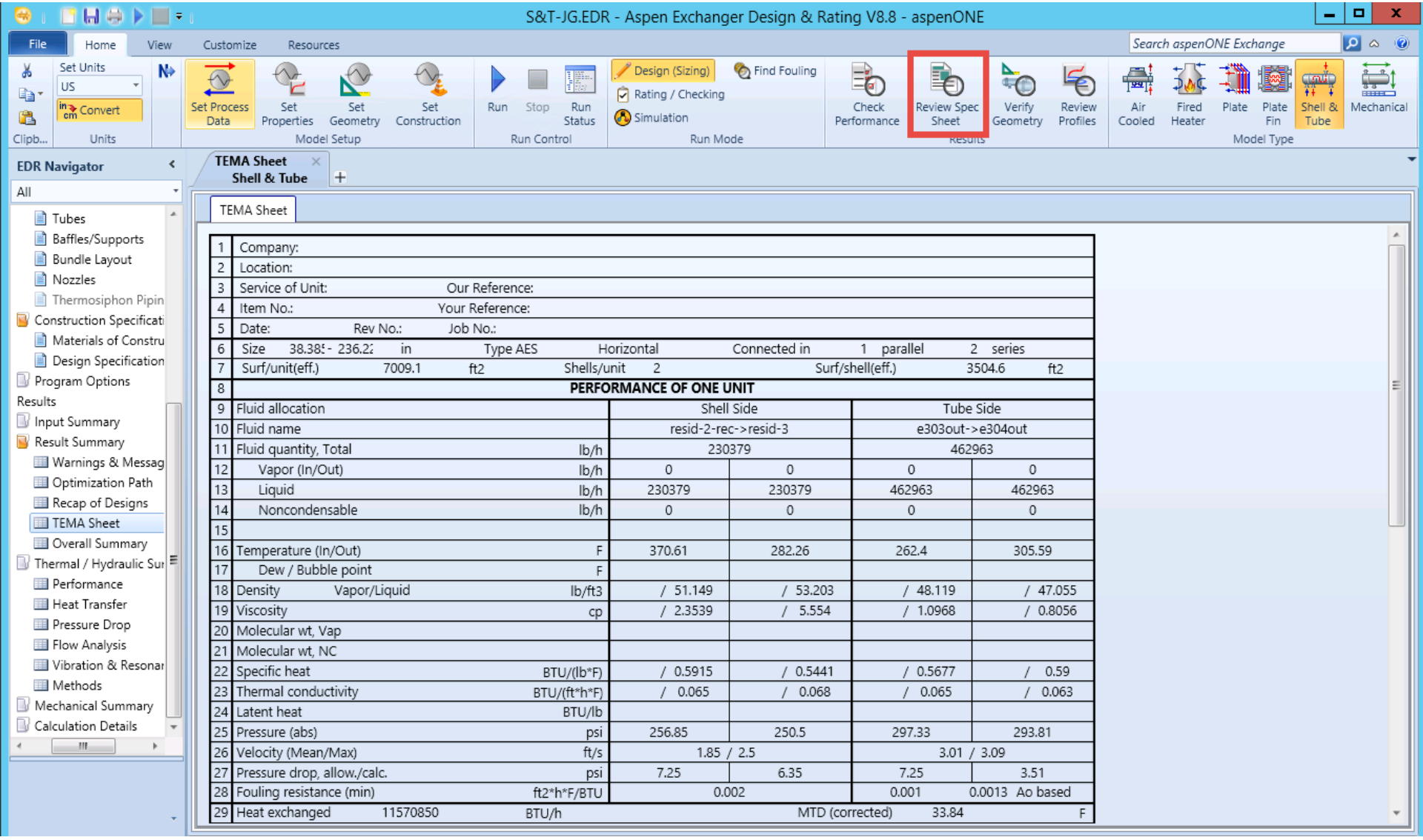
Click on the ‘Run’ Button to size the heat exchanger. Notice that there are two Input warnings with this design, but no errors.

Check Overall Performance



aspentech

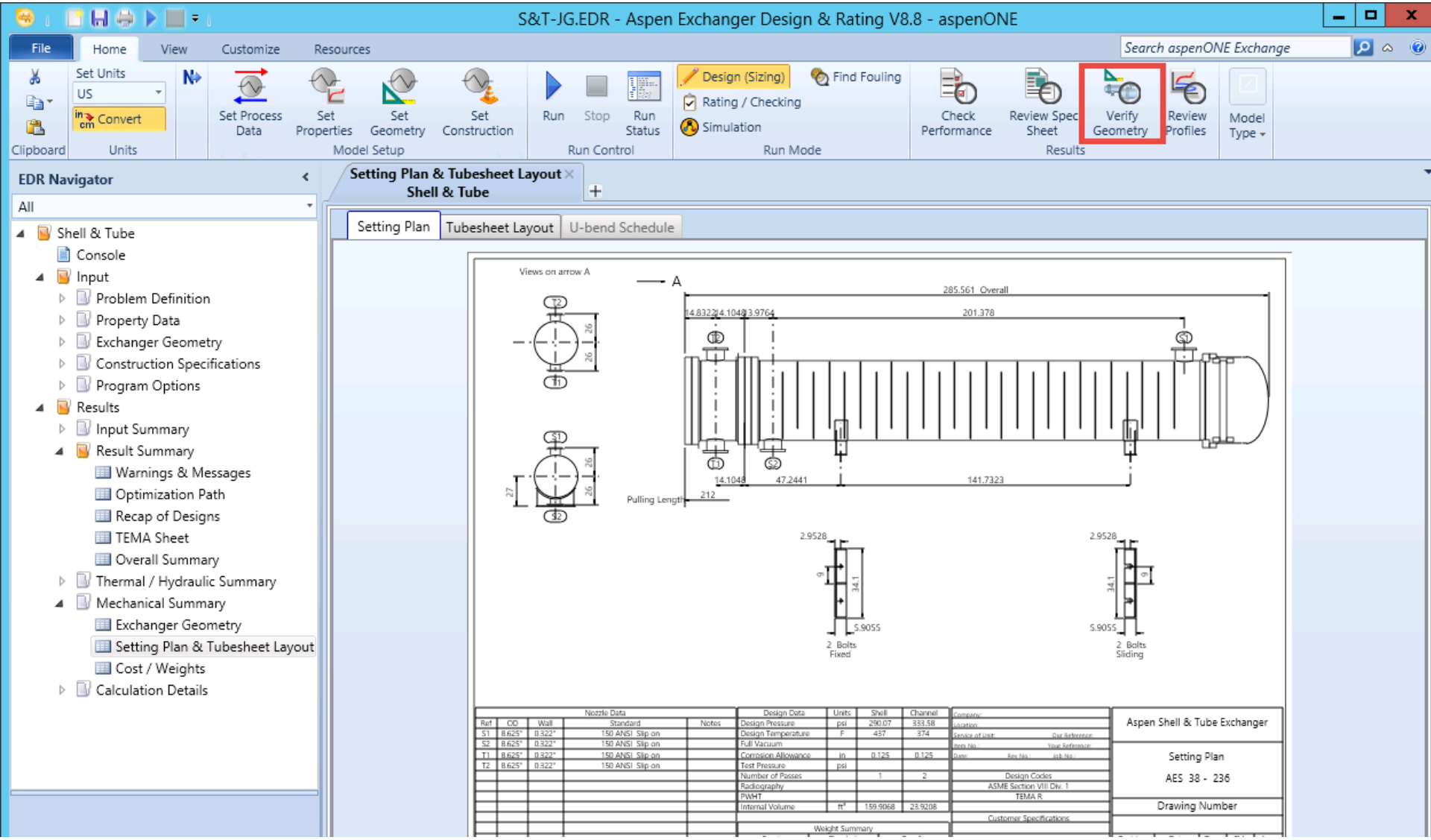
View TEMA Sheet



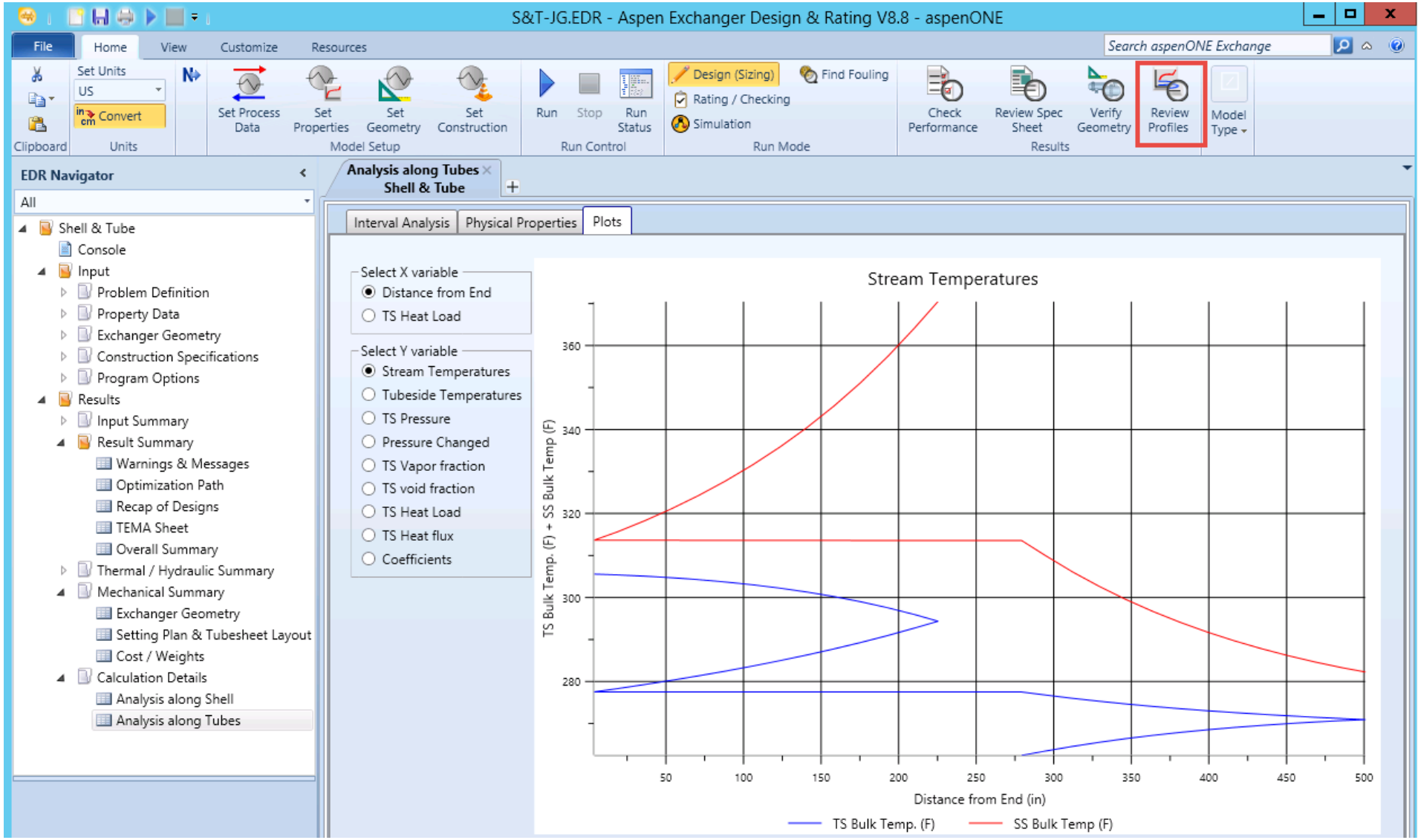
1	Company:					
2	Location:					
3	Service of Unit:		Our Reference:			
4	Item No.:		Your Reference:			
5	Date:	Rev No.:	Job No.:			
6	Size 38.38 - 236.2 in	Type AES	Horizontal	Connected in 1 parallel	2 series	
7	Surf/unit(eff.) 7009.1 ft2	Shells/unit 2		Surf/shell(eff.) 3504.6 ft2		
8	**PERFORMANCE OF ONE UNIT**					
9	Fluid allocation		Shell Side		Tube Side	
10	Fluid name		resid-2-rec->resid-3		e303out->e304out	
11	Fluid quantity, Total	lb/h	230379		462963	
12	Vapor (In/Out)	lb/h	0	0	0	0
13	Liquid	lb/h	230379	230379	462963	462963
14	Noncondensable	lb/h	0	0	0	0
15						
16	Temperature (In/Out)	F	370.61	282.26	262.4	305.59
17	Dew / Bubble point	F				
18	Density Vapor/Liquid	lb/ft3	/ 51.149	/ 53.203	/ 48.119	/ 47.055
19	Viscosity	cp	/ 2.3539	/ 5.554	/ 1.0968	/ 0.8056
20	Molecular wt, Vap					
21	Molecular wt, NC					
22	Specific heat	BTU/(lb*F)	/ 0.5915	/ 0.5441	/ 0.5677	/ 0.59
23	Thermal conductivity	BTU/(ft*h*F)	/ 0.065	/ 0.068	/ 0.065	/ 0.063
24	Latent heat	BTU/lb				
25	Pressure (abs)	psi	256.85	250.5	297.33	293.81
26	Velocity (Mean/Max)	ft/s	1.85 / 2.5		3.01 / 3.09	
27	Pressure drop, allow./calc.	psi	7.25	6.35	7.25	3.51
28	Fouling resistance (min)	ft2*h*F/BTU	0.002		0.001	0.0013 Ao based
29	Heat exchanged 11570850	BTU/h		MTD (corrected) 33.84		F

aspentech

Verify Heat Exchanger Geometry



Review Profiles



Tutorial II

Heat Exchanger Specification Sheet

Values from this Heat Exchanger specification sheet would be used for the exercise.

Relevant values are highlighted in yellow.

Heat Exchanger Specification Sheet

Company:									
Location:									
Service of Unit:		Our Reference: Aspen Shell & Tube Exchanger Stand-alone Task							
Item No.:		Your Reference:							
Date:	Rev No.:	Job No.:							
Size	/	in	Type	AES	Hor	Connected in		parallel	series
Surf/unit(eff.)		ft2	Shells/unit			Surf/shell (eff.)			ft2
PERFORMANCE OF ONE UNIT									
Fluid allocation			**Shell Side**			**Tube Side**			
Fluid name			P3G1->P3G2			P3GA-Alt->P3GA-1			
Fluid quantity, Total		lb/h	1122792			546607			
Vapor (In/Out)		lb/h	0	0		0	0		
Liquid		lb/h	1122792	1122792		546607	546607		
Noncondensable		lb/h	0			0			
Temperature (In/Out)		F	486.61	478.88		466.52	482.6		
Dew / Bubble point		F							
Density (Vap / Liq)		lb/ft3	/ 42.537	/ 42.78		/ 43.157	/ 42.661		
Viscosity		cp	/ 0.3588	/ 0.374		/ 0.3991	/ 0.3662		
Molecular wt, Vap									
Molecular wt, NC									
Specific heat		BTU/(lb*F)	/ 0.6655	/ 0.662		/ 0.6566	/ 0.6639		
Thermal conductivity		BTU/(ft*h*F)	/ 0.046	/ 0.046		/ 0.047	/ 0.046		
Latent heat		BTU/lb							
Pressure (abs)		psi	178.1	156.99		156.99	139.5		
Velocity		ft/s							
Pressure drop, allow./calc.		psi	21.76			21.76			
Fouling resistance (min)		ft2*h*F/BTU	0.0011			0.0011	0.0015	Ao based	
Heat exchanged	5792424	BTU/h			MTD corrected			F	
Transfer rate, Service			Dirty		Clean			BTU/(h*ft2*F)	

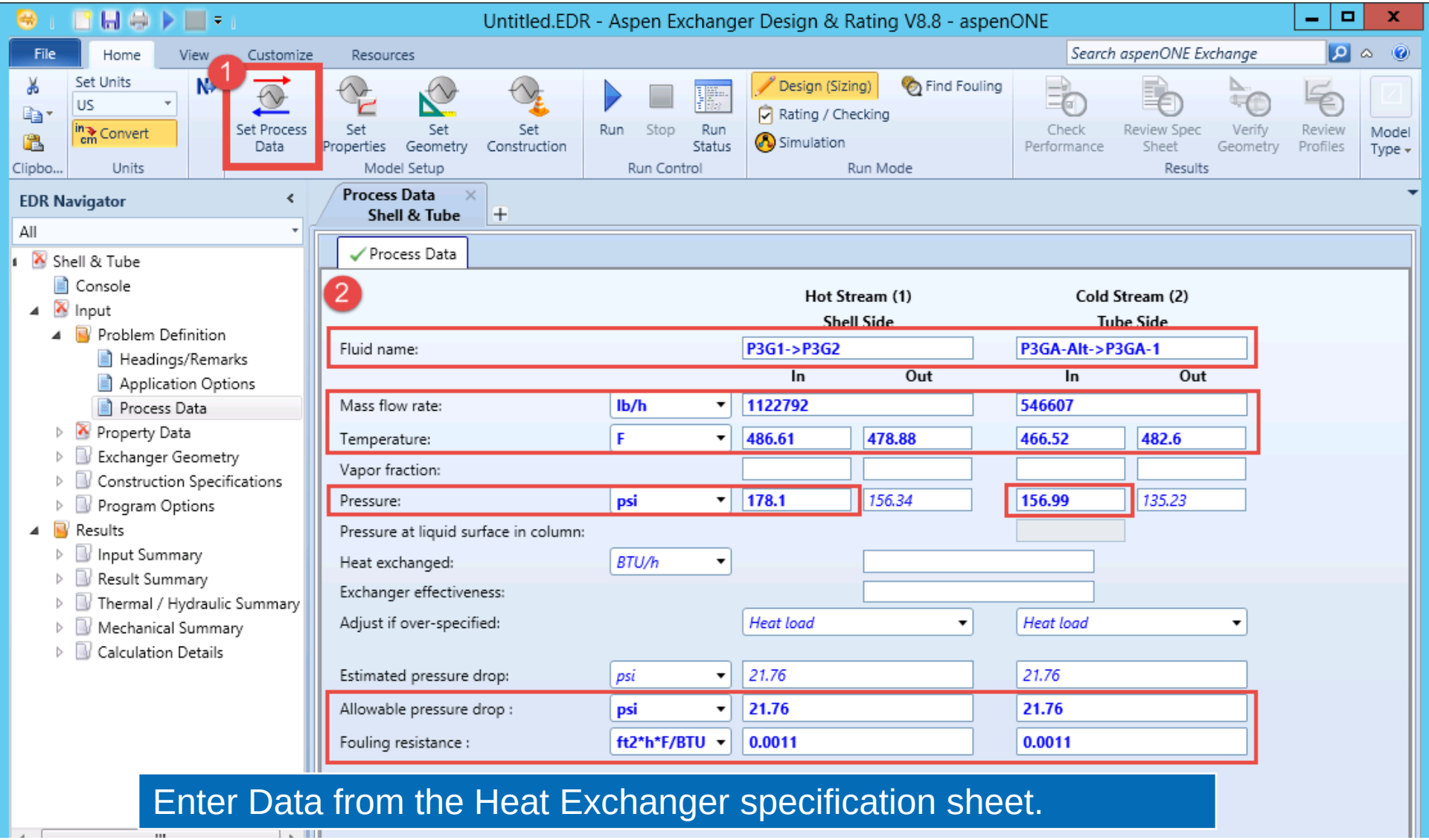
aspentech

Heat Exchanger Specification Sheet

Transfer rate, Service							Dirty					Clean								BTU/(h*ft2*F)	
CONSTRUCTION OF ONE SHELL																			Sketch		
				Shell Side						Tube Side											
Design/vac/test pressure:			psi	200	/		/			180	/		/								
Design temperature			F	554						554											
Number passes per shell																					
Corrosion allowance			in																		
Connections	In		in	1	16	/	-			1	10	/	-								
Size/rating	Out			1	16	/	-			1	10	/	-								
ID	Intermediate			1		/	-			1		/	-								
Tube No.		OD		1		Tks- Avg			in		Lengtl		in		Pitch			in			
Tube type	Plain						Material			Carbon Steel				Tube pattern		90					
Shell	Carbon Steel			ID			OD		in		Shell cover			Carbon Steel							
Channel or bonnet				Carbon Steel							Channel cover			Carbon Steel							
Tubesheet-stationary				Carbon Steel							Tubesheet-floating			Carbon Steel							
Floating head cover				Carbon Steel							Impingement protection			None							
Baffle-cross	Carbon Steel			Type	Double segmer		Cut(%d)			H	Spacing: c/c							in			
Baffle-long	-				Seal type								Inlet					in			
Supports-tube					U-bend					Type											
Bypass seal							Tube-tubesheet joint				Exp.										
Expansion joint	-						Type														
RhoV2-Inlet nozzle				Bundle entrance							Bundle exit							lb/(ft*s2)			
Gaskets - Shell side		Flat Metal Jacket Fibe					Tube Side			Flat Metal Jacket Fibe											
Floating head		Flat Metal Jacket Fibe																			
Code requirements		ASME Code Sec VIII Div 1								TEMA class				R - refinery service							
Weight/Shell				Filled with water										Bundle				lb			
Remarks																					

aspentech

Set Process Data



Enter Data from the Heat Exchanger specification sheet.

aspentech

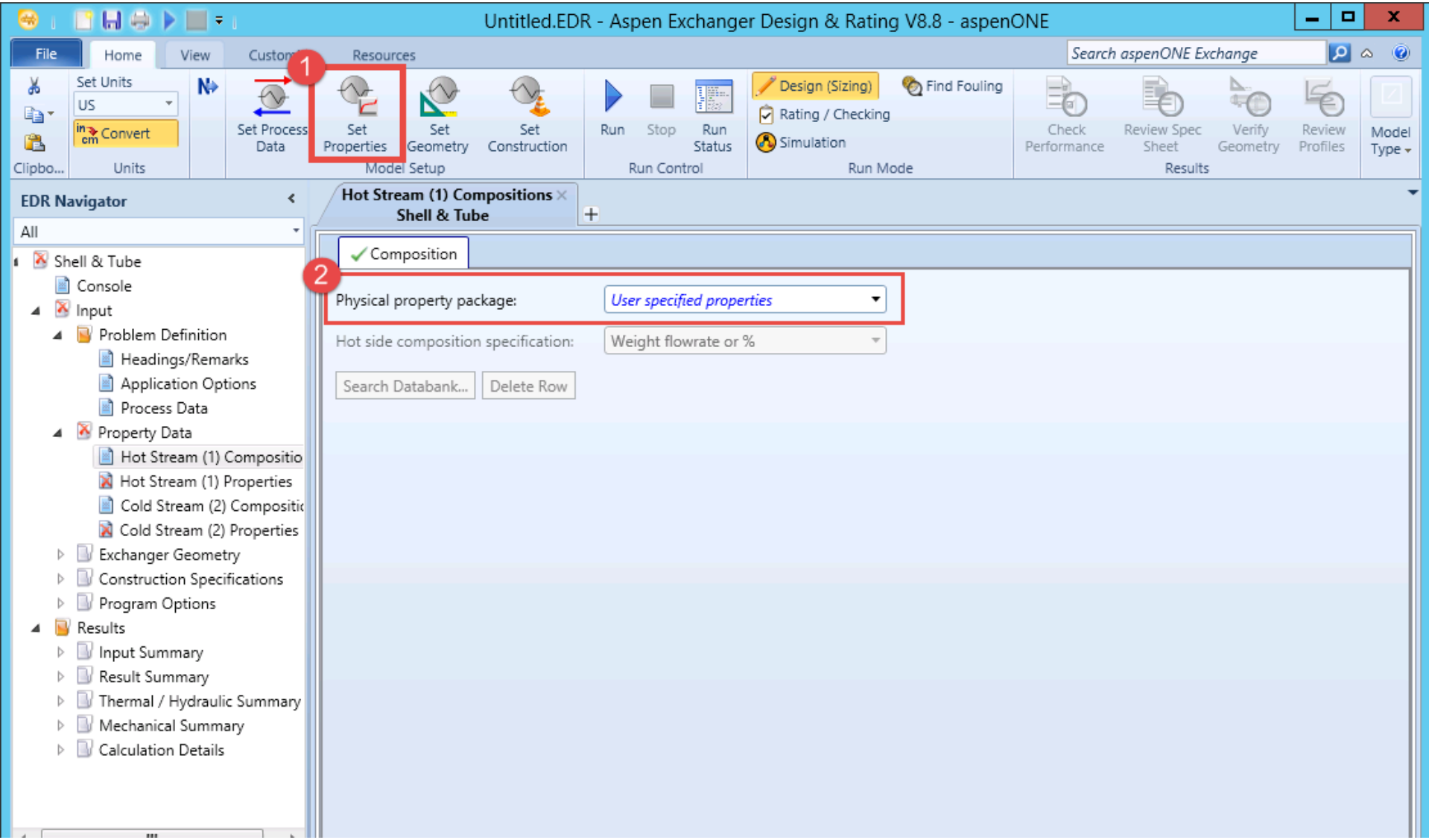
Stream Properties Data

For Hot Stream and Cold stream properties use the data given here.

Hot Stream Properties at 178.1 psi				
		1	2	3
Temperature	F	486.61	476.57	466.52
Liquid density	lb/ft3	42.537	42.862	43.181
Liquid specific heat	BTU/(lb*F)	0.6655	0.661	0.6565
Liquid viscosity	cp	0.3588	0.3785	0.3993
Liquid thermal cond.	BTU/(ft*h*F)	0.046	0.046	0.047
Liquid surface tension	lbf/ft	0.00068	0.00071	0.00073
Liquid molecular weight		245.767	245.767	245.767

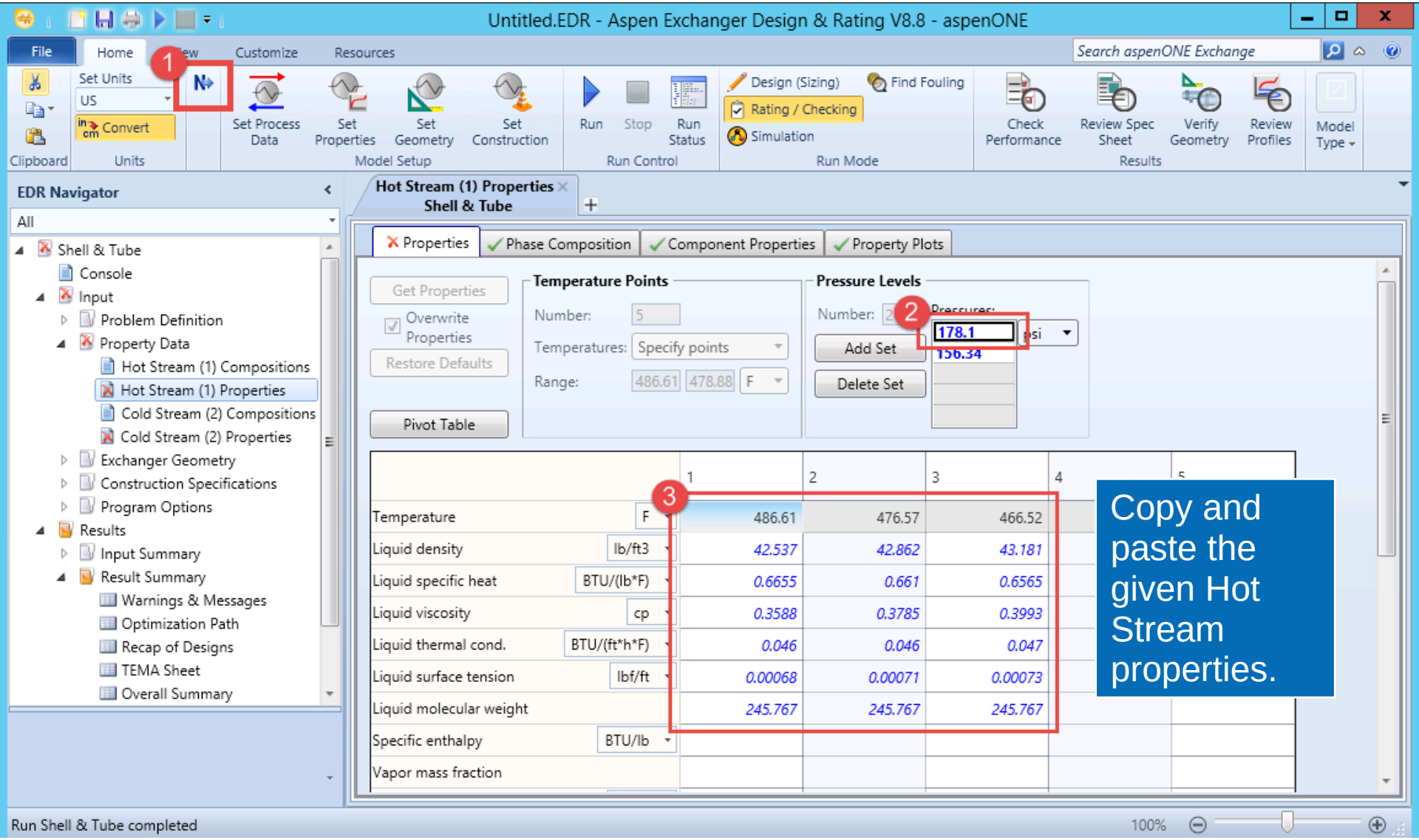
Cold Stream Properties at 157.1 psi							
		1	2	3	4	5	6
Temperature	F	466.52	470.54	474.56	478.58	482.59	486.61
Liquid density	lb/ft3	43.157	43.031	42.908	42.785	42.661	42.537
Liquid specific heat	BTU/(lb*F)	0.6566	0.6584	0.6602	0.662	0.6638	0.6656
Liquid viscosity	cp	0.3991	0.3907	0.3825	0.3743	0.3663	0.3587
Liquid thermal cond.	BTU/(ft*h*F)	0.047	0.047	0.046	0.046	0.046	0.046
Liquid surface tension	lbf/ft	0.00073	0.00072	0.00071	0.0007	0.00069	0.00068
Liquid molecular weight		245.7668	245.7668	245.7668	245.7668	245.7668	245.7668

Set Hot Stream Properties



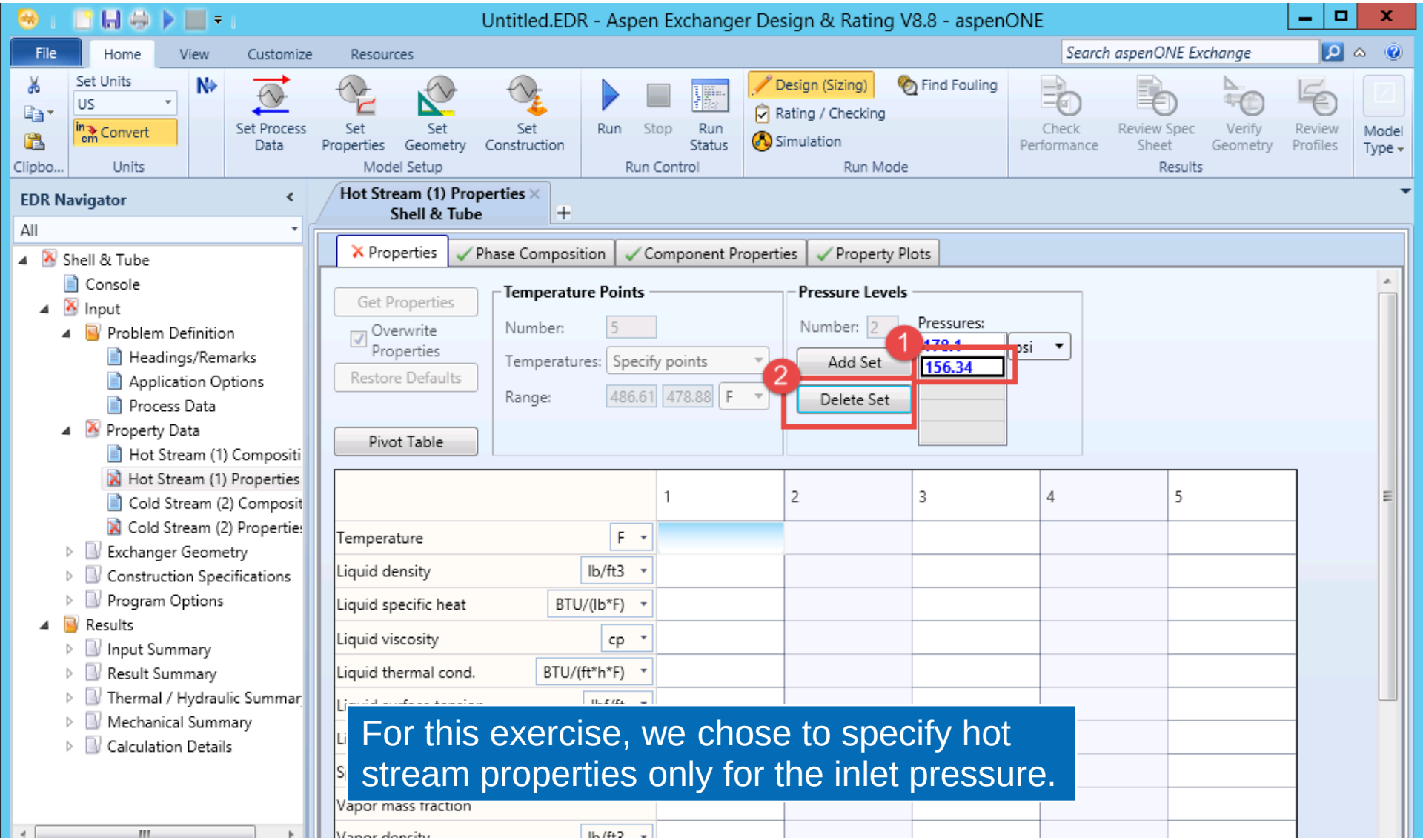
aspentech

Set Hot Stream Properties



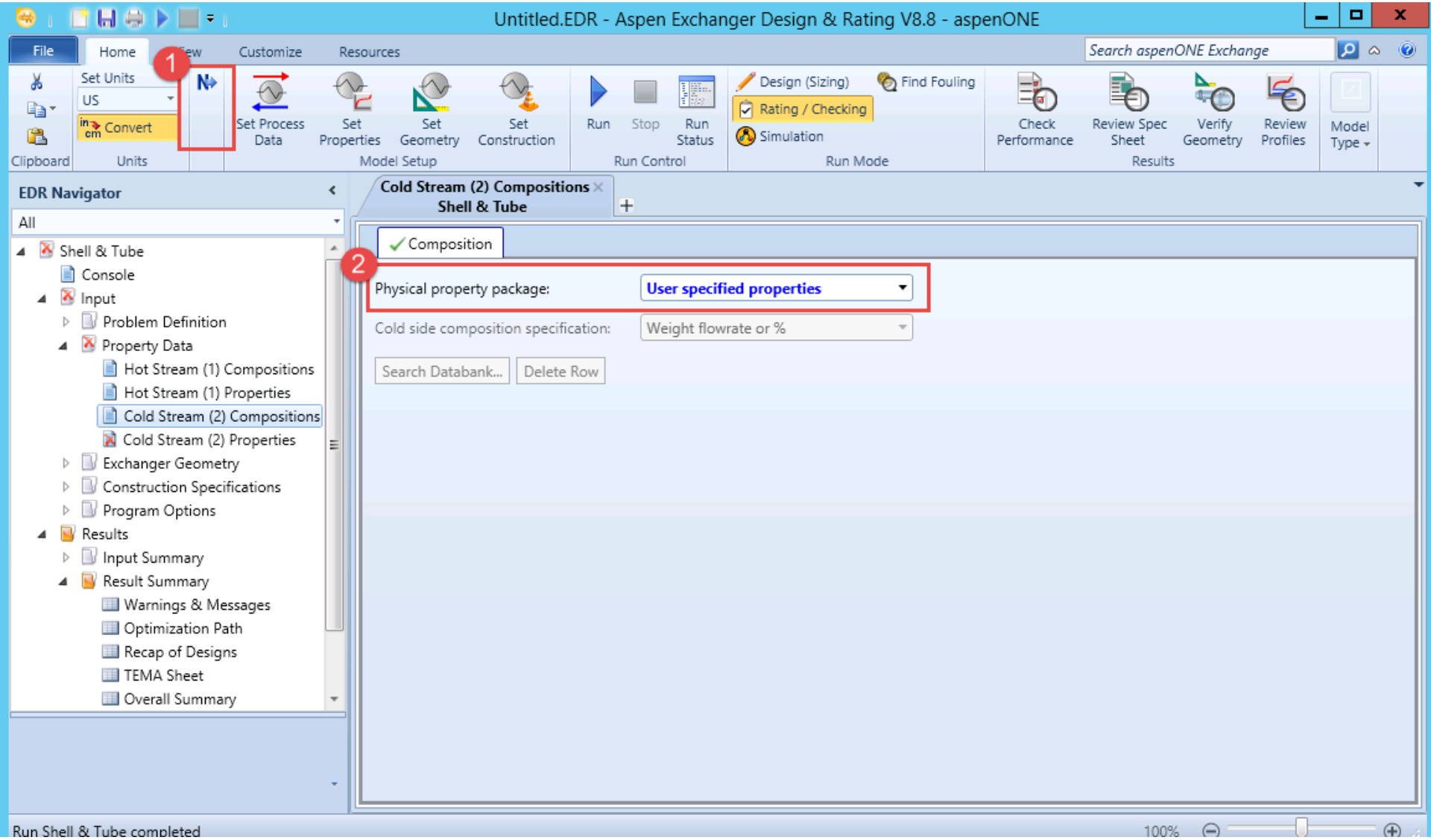
aspentech

Set Hot Stream Properties



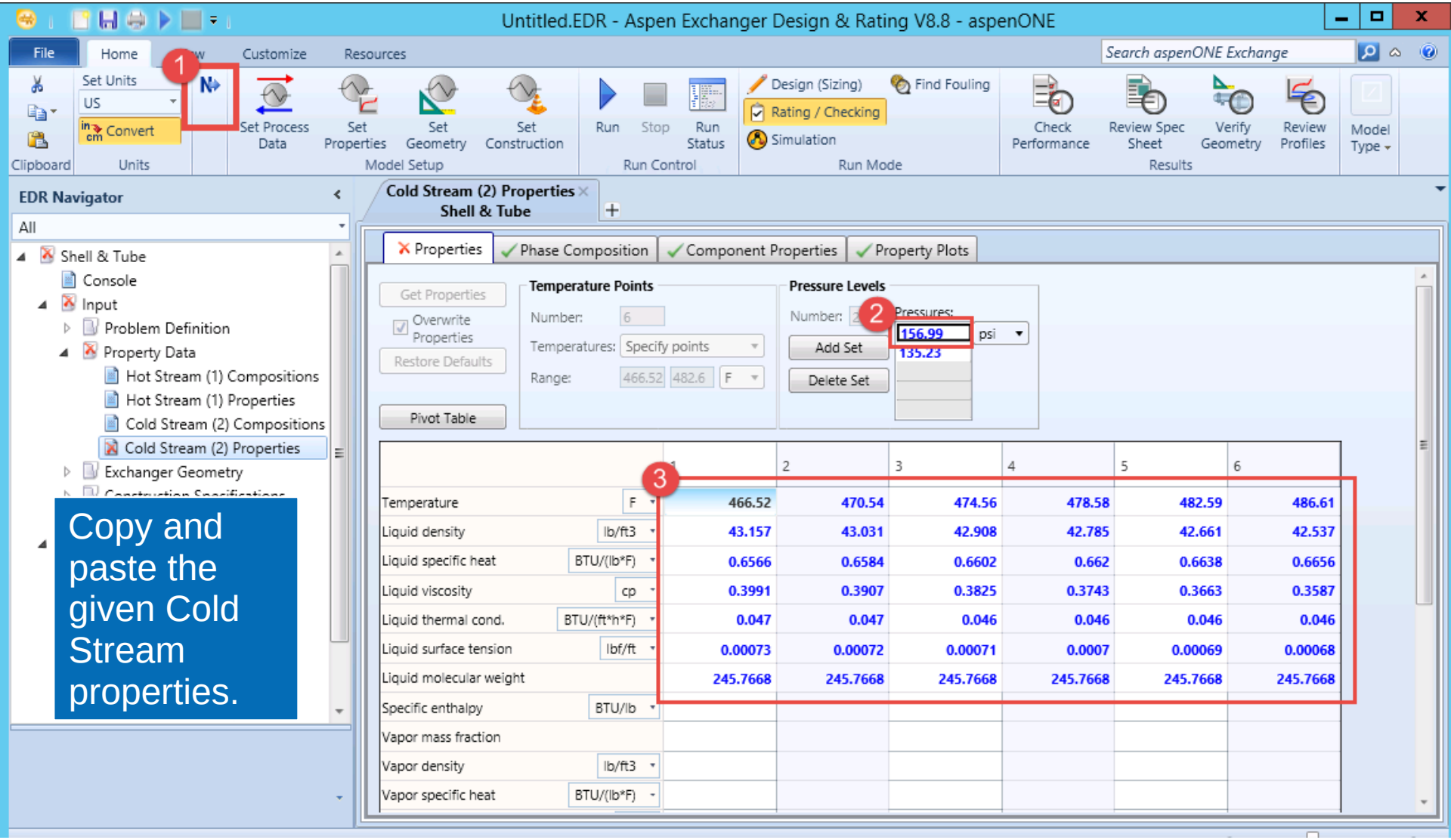
aspentech

Set Cold Stream Properties



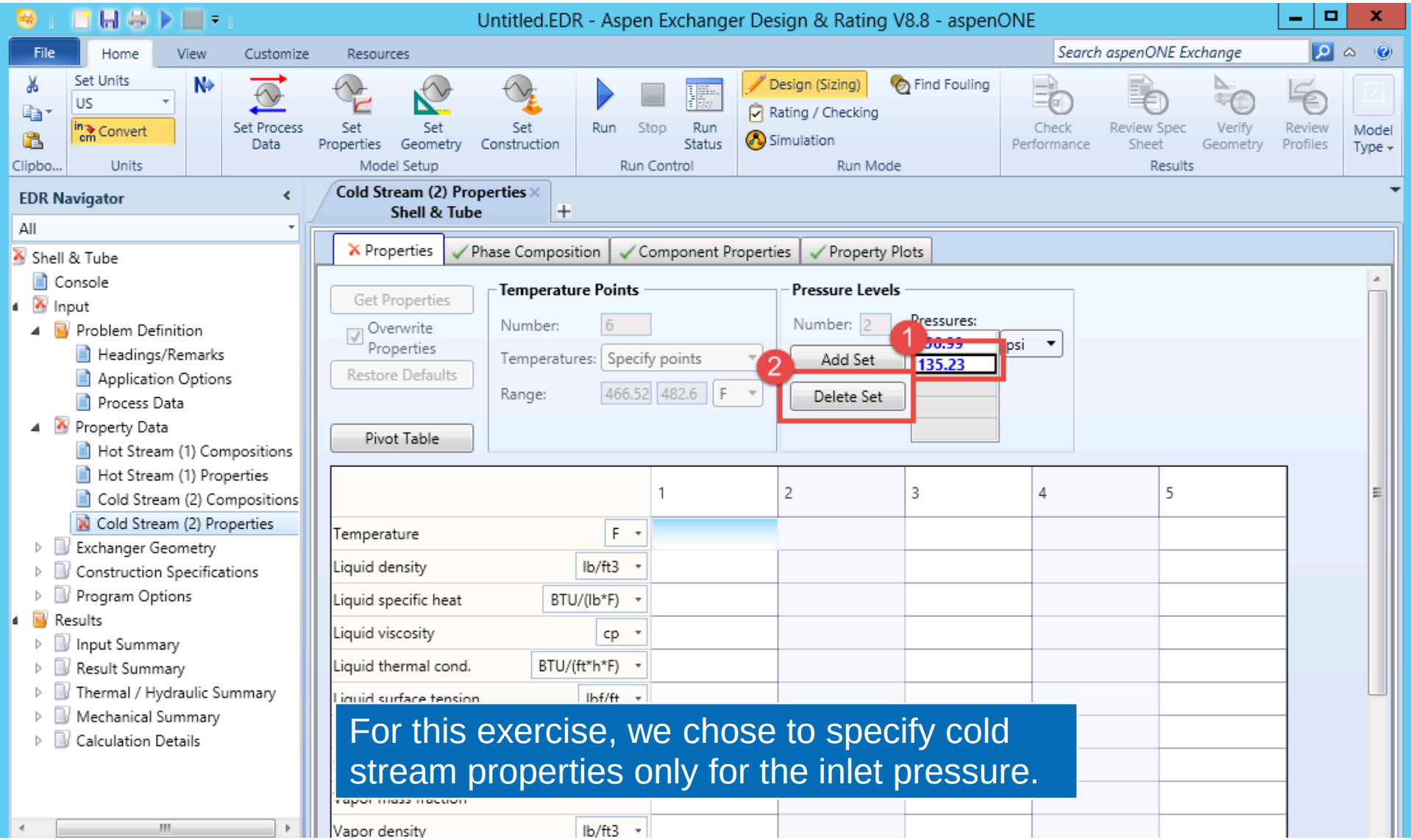
aspentech

Set Cold Stream Properties



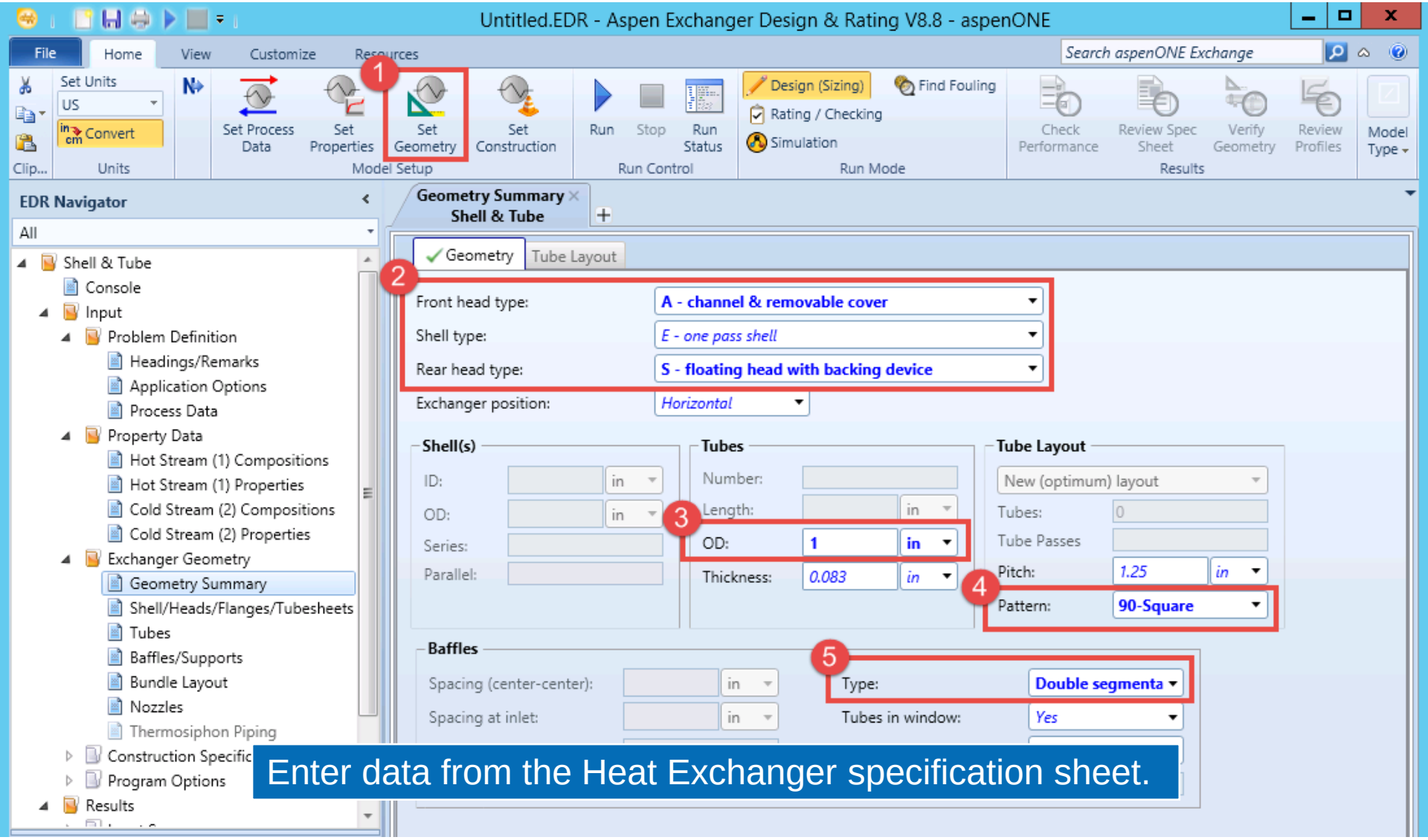
aspentech

Set Cold Stream Properties



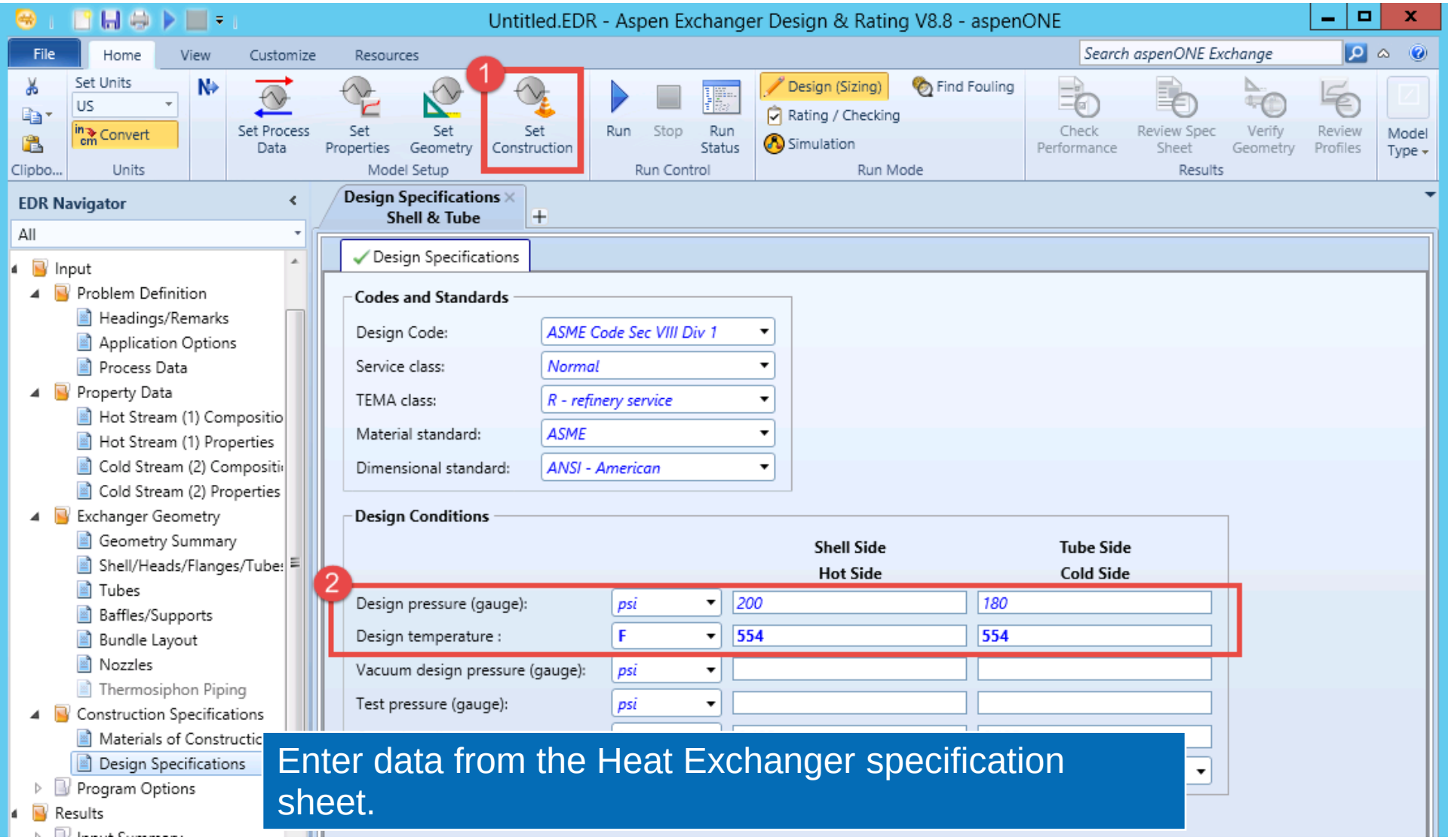
aspentech

Set Geometry



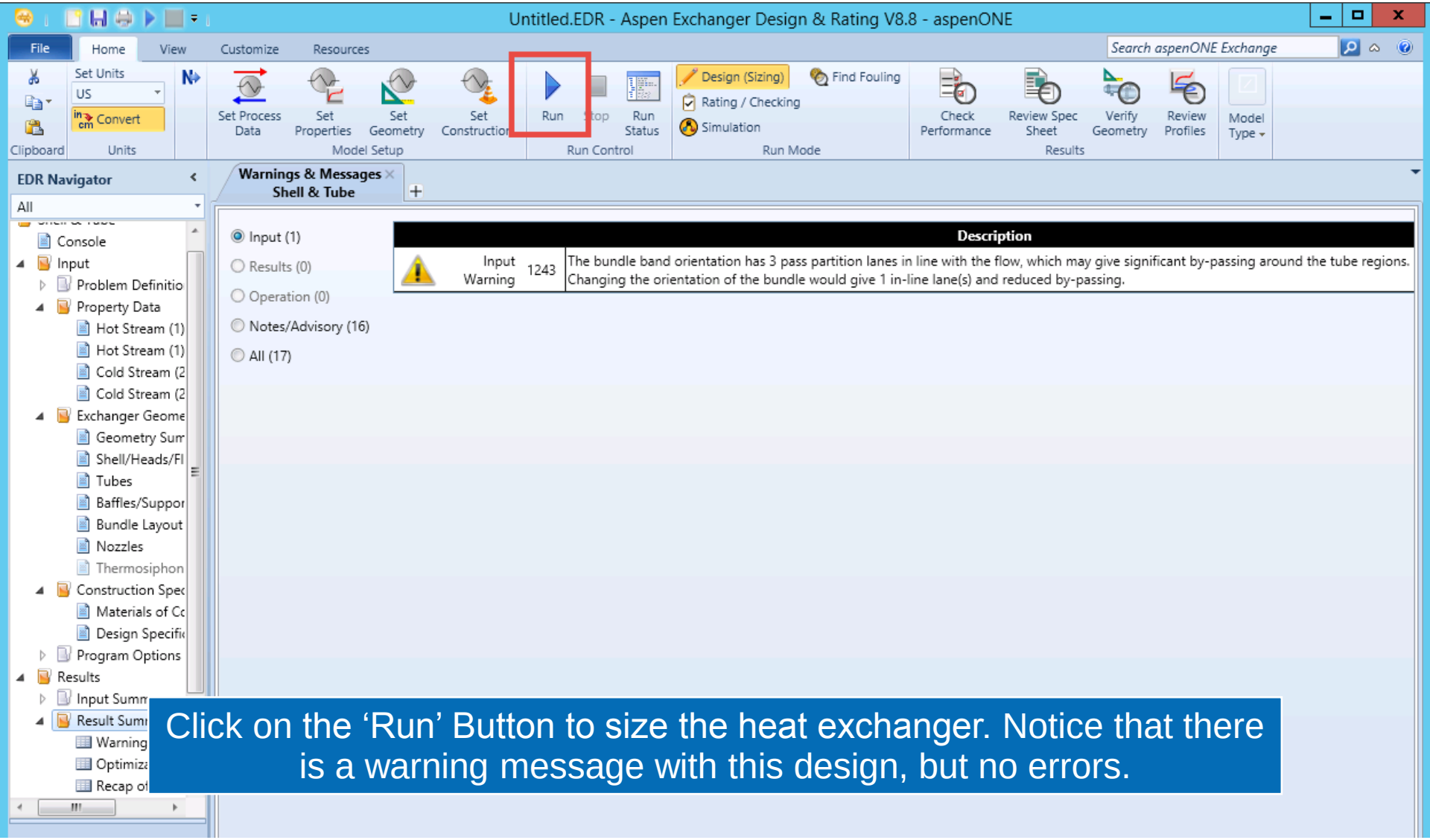
aspentech

Enter Design Specification



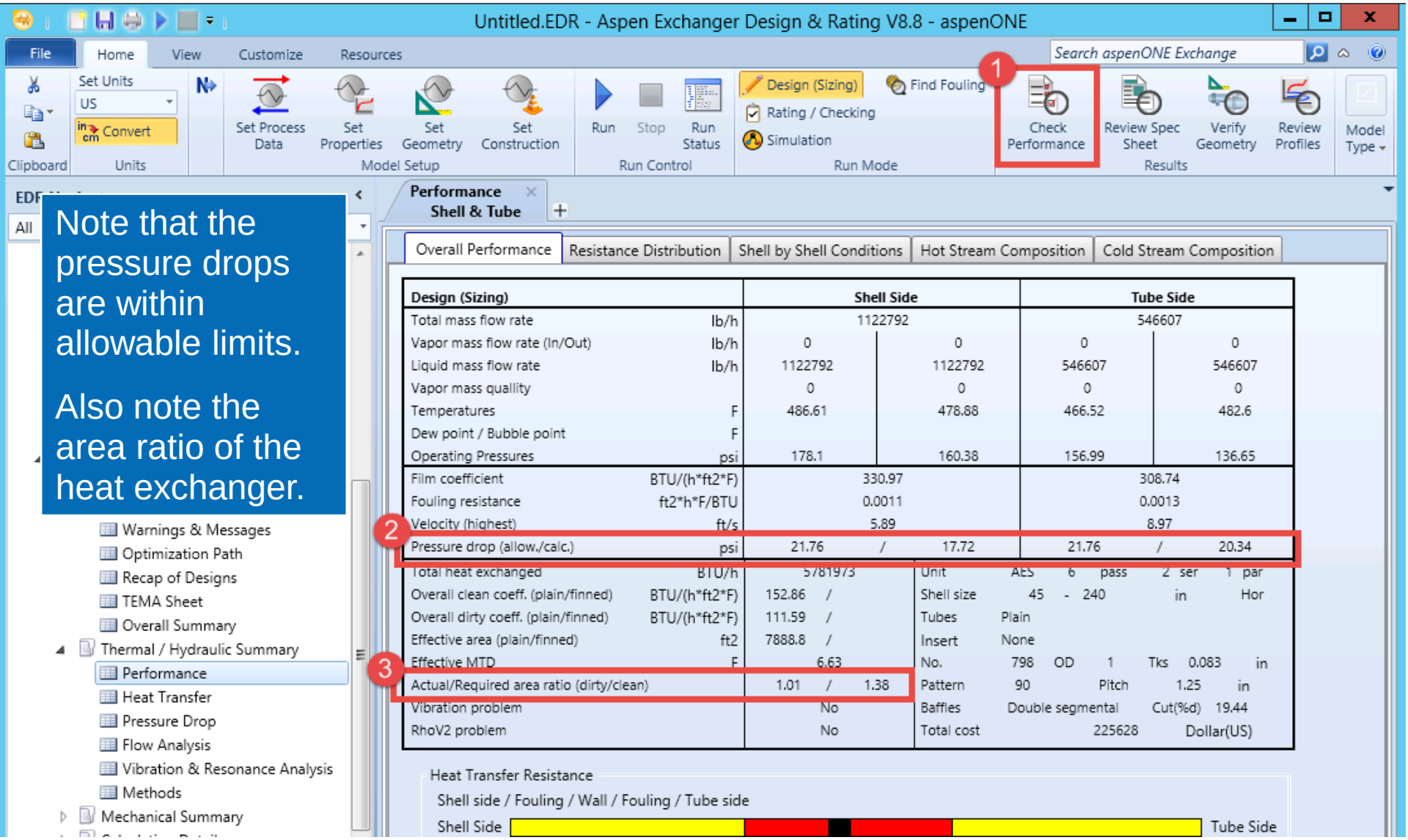
aspentech

Run Sizing Optimization



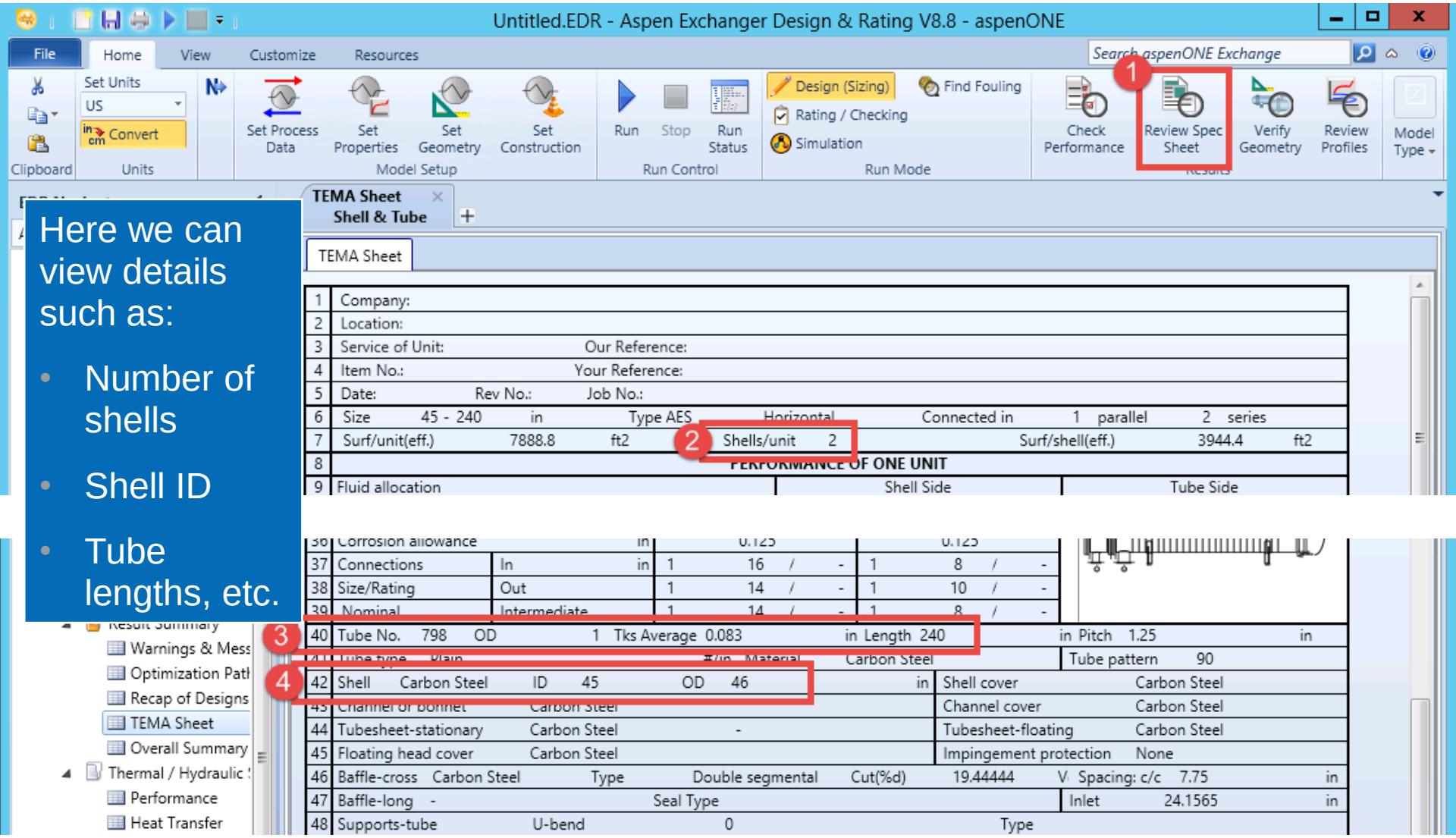
Click on the ‘Run’ Button to size the heat exchanger. Notice that there is a warning message with this design, but no errors.

Check Overall Performance



aspentech

View TEMA Sheet

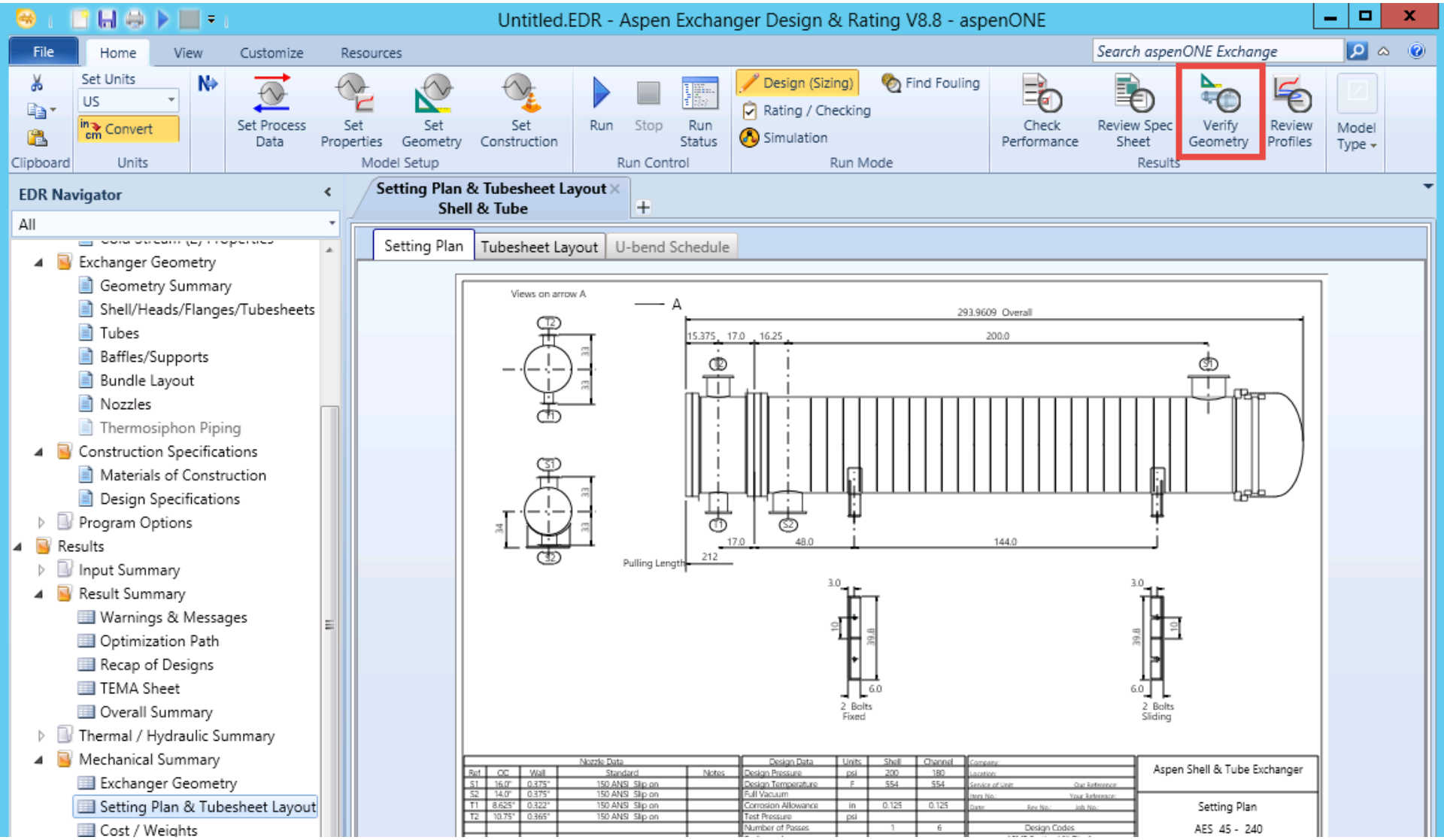


Here we can view details such as:

- Number of shells
- Shell ID
- Tube lengths, etc.

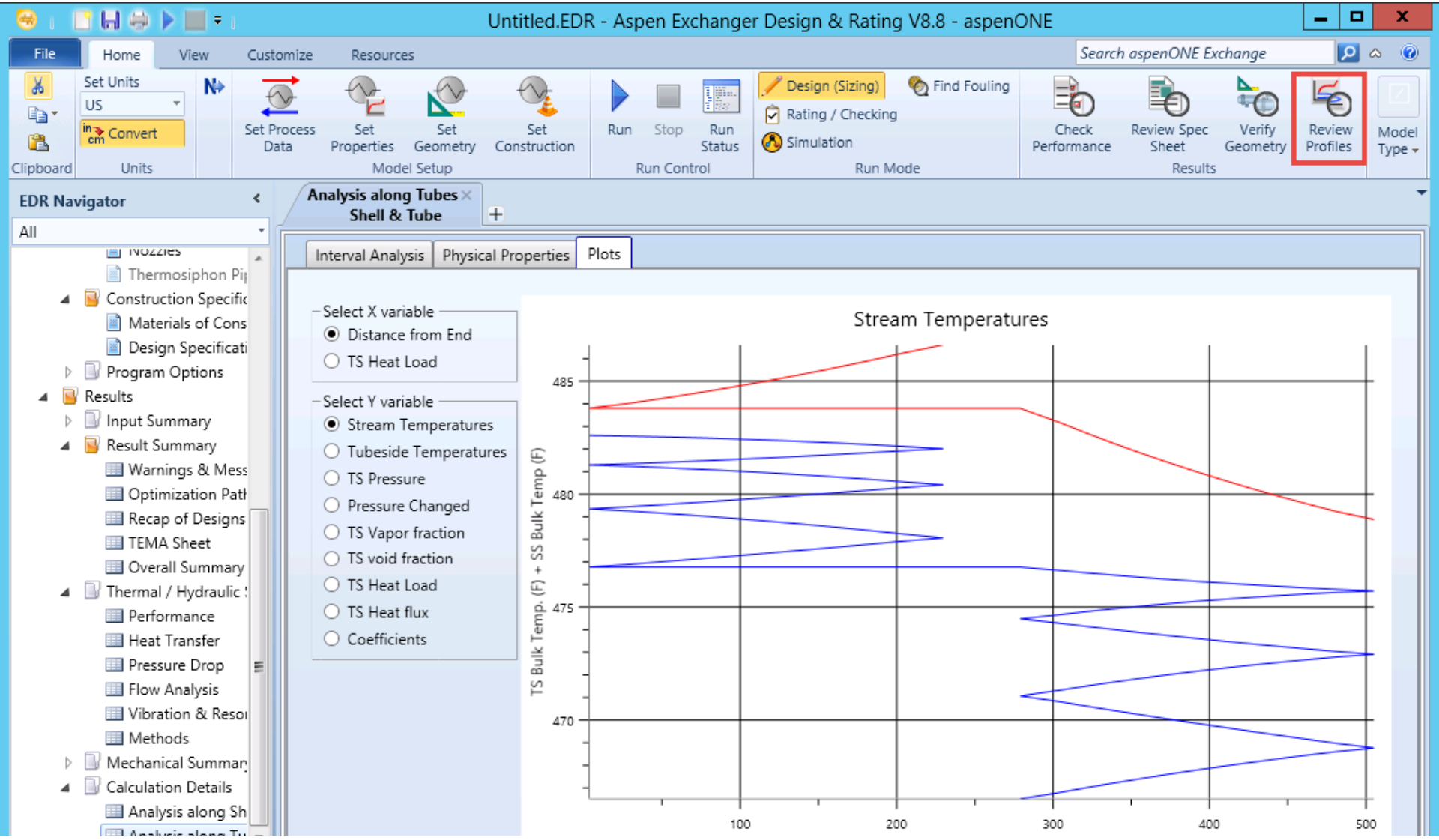
aspentech

View Setting Plan

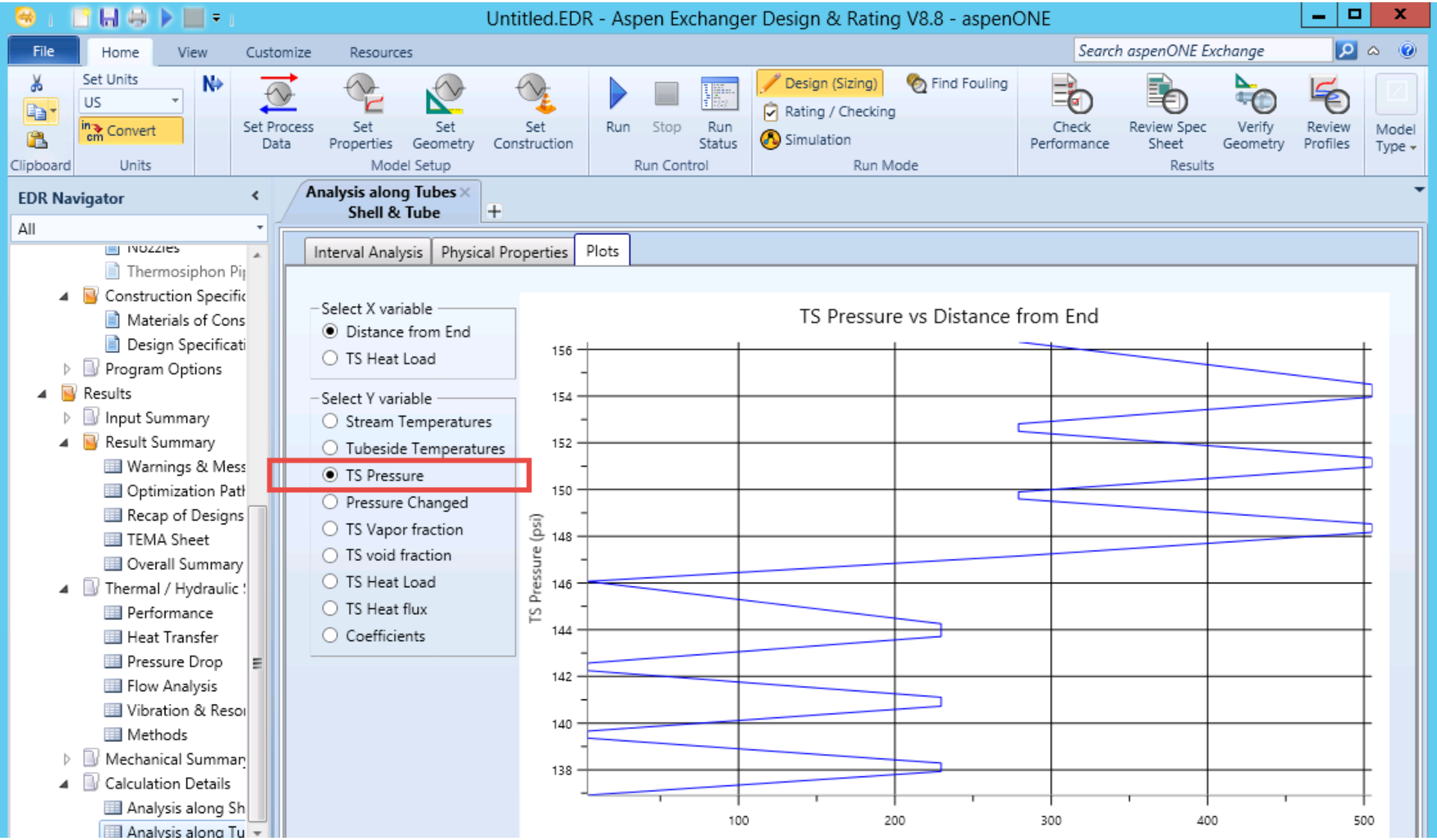


aspentech

View Stream Temperature Profiles

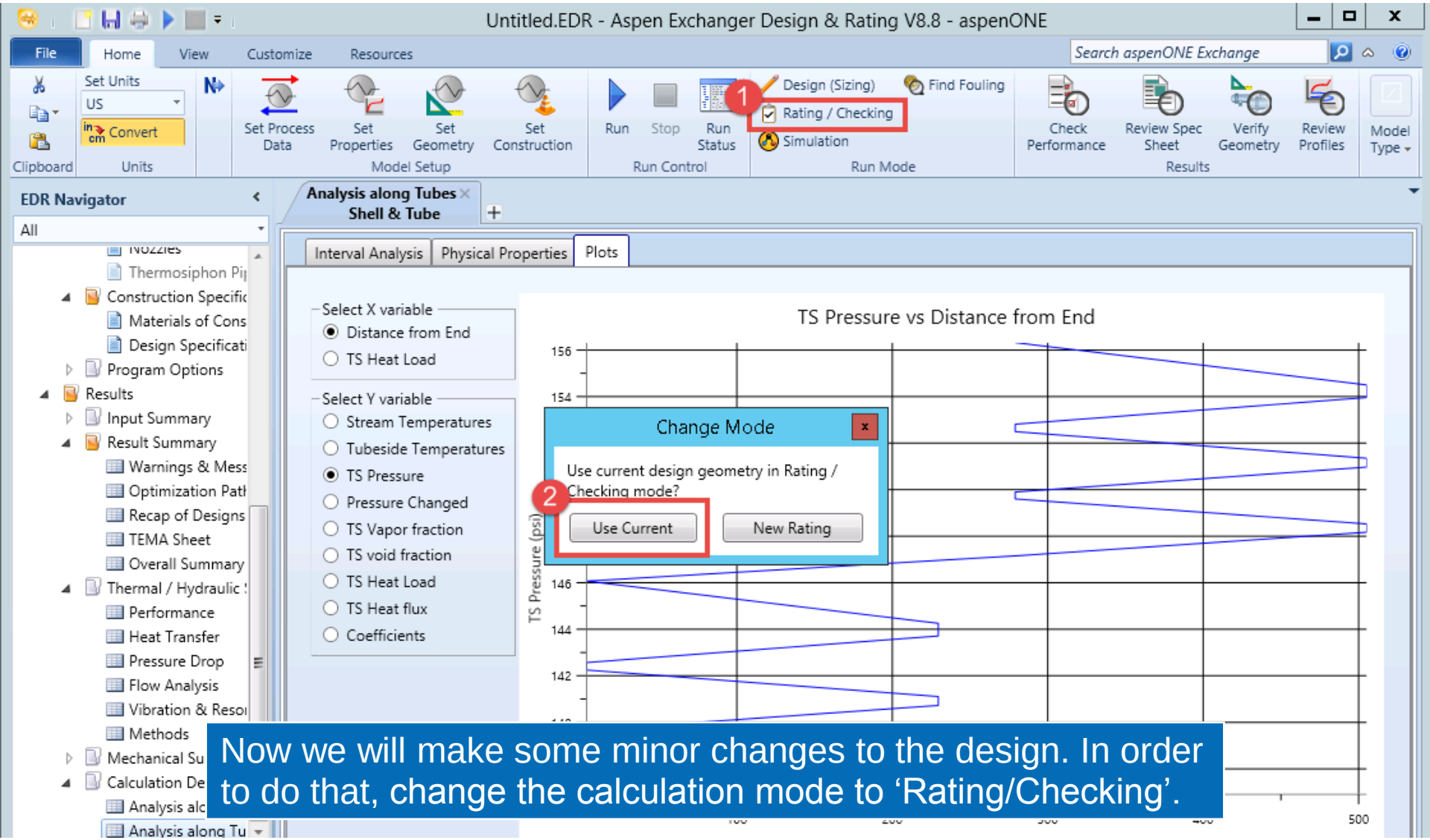


View Pressure Profiles



aspentech

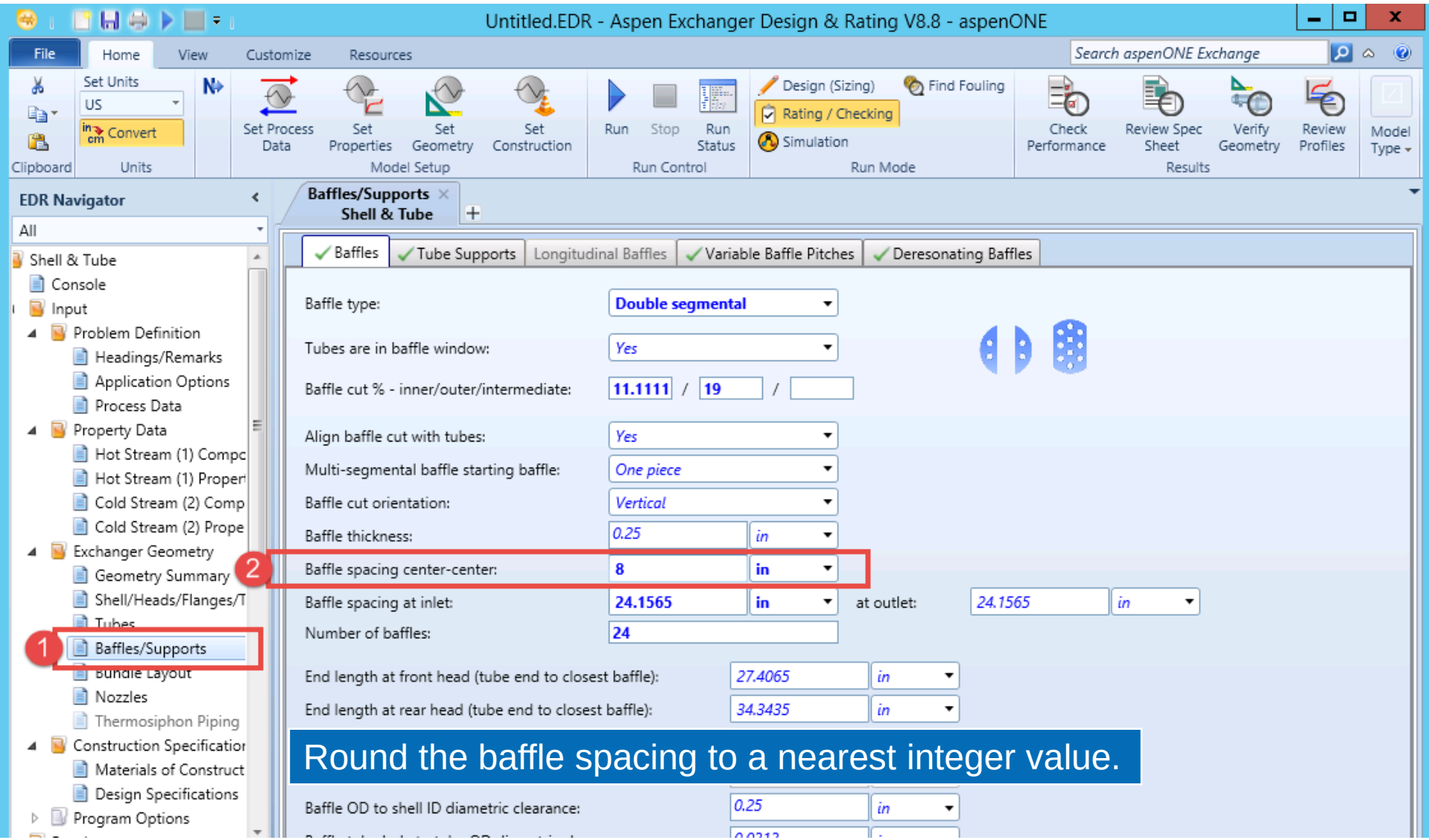
Modify Design



Now we will make some minor changes to the design. In order to do that, change the calculation mode to ‘Rating/Checking’.

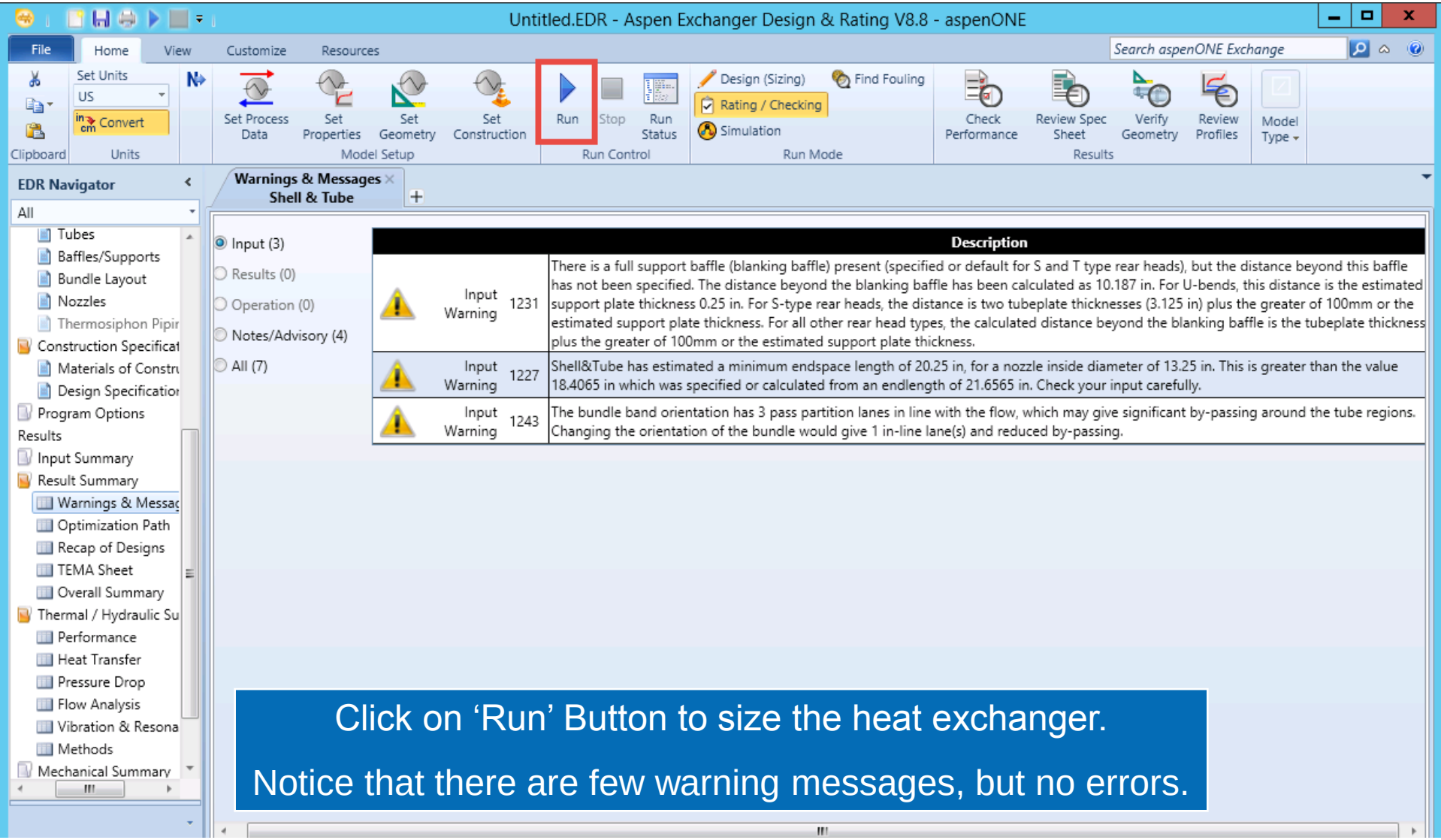
aspentech

Round Off Baffle Spacing

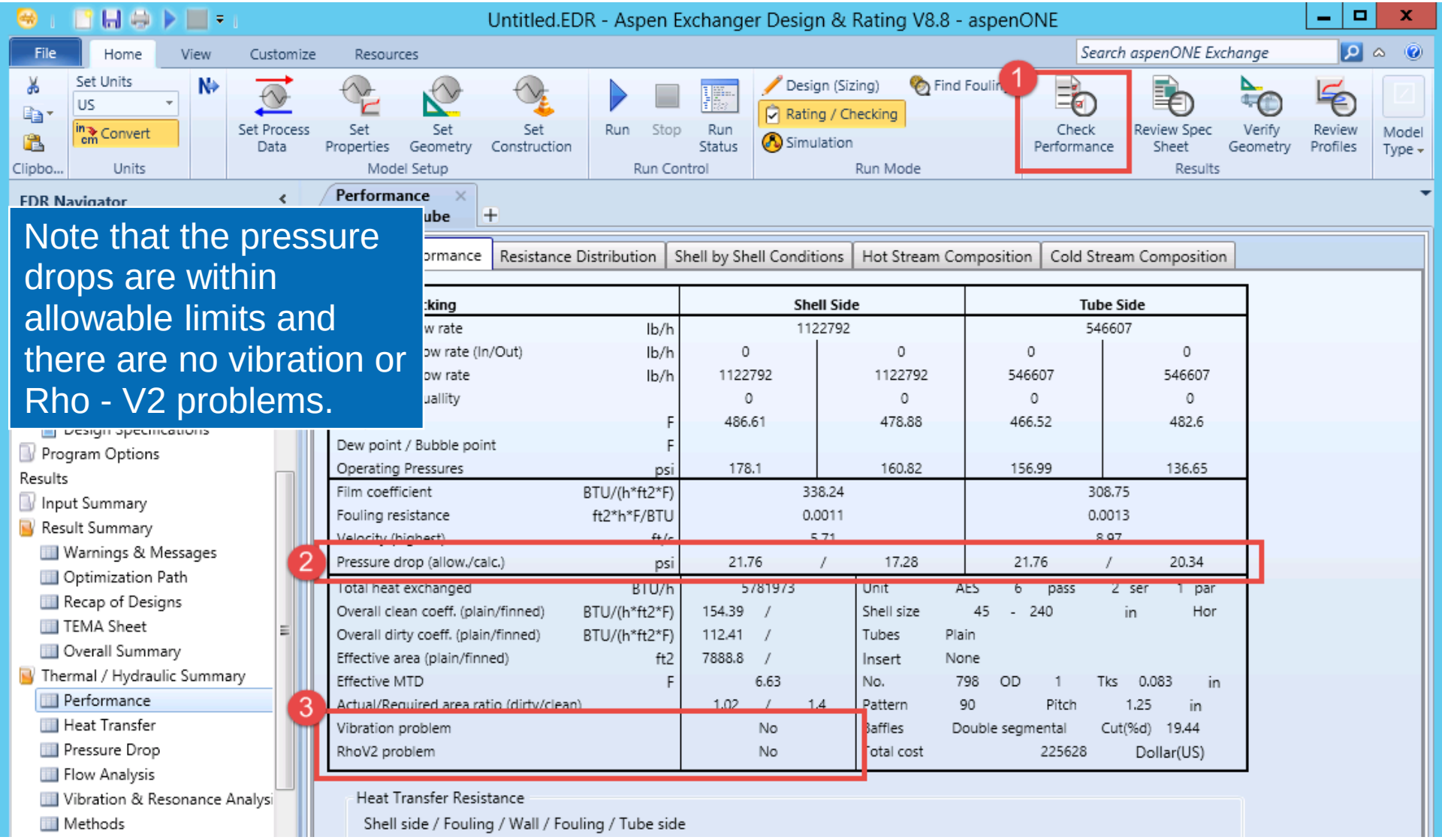


aspentech

Run Sizing Optimization



Check Overall Performance



Note that the pressure drops are within allowable limits and there are no vibration or Rho - V2 problems.

Additional Resources & Contacts

- AspenTech Support Website (http://support.aspentech.com)
- AspenTech Courseware Available in Classroom and Online Versions
- AspenTech Business Consultants

Contact Name	Contact Email
Sandeep Mohan	Sandeep.Mohan@aspentech.com