

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

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

Why Use Aspen Shell & Tube Mechanical?

Aspen Shell & Tube Mechanical optimizes the design of all mechanical components, and performs detailed code calculations, customized cost estimates, detailed drawing packages, and a complete bill of materials.

When used with Aspen Shell & Tube Exchanger, Aspen Shell & Tube Mechanical ensures consistency between thermal and mechanical designs. This enables engineers to both optimize and efficiently validate the thermal and mechanical designs of shell and tube heat exchangers.

When used as a standalone program in design mode, Aspen Shell & Tube Mechanical can optimize the design of a full shell and tube exchanger with minimal input calculating flanges, tube sheets, expansion joints, supports, shell, and nozzle reinforcement.

Why Use Aspen Shell & Tube Mechanical?

Obtain a detailed mechanical design of Aspen Shell & Tube Exchanger and be able to:

- Perform detailed code calculations for all components
- Obtain detailed drawing packages
- Get a complete bill of materials
- Get customize cost estimates - material & labor

Objective

This document serves as a simple “getting started” guide, showing you the most common progression of how an equipment designer would use Aspen Shell & Tube Mechanical to generate an optimal heat exchanger design.

This guide demonstrates how to:

- Specify input data
- Run the program
- View key results
- Transfer results to other formats

Open Aspen Shell & Tube Mechanical

The screenshot displays the Aspen Exchanger Design & Rating V8.8 software interface. The window title is "- Aspen Exchanger Design & Rating V8.8 - aspenONE". The interface includes a menu bar with "File", "Customize", and "Resources". A search bar on the right contains the text "Search aspenONE Exchange".

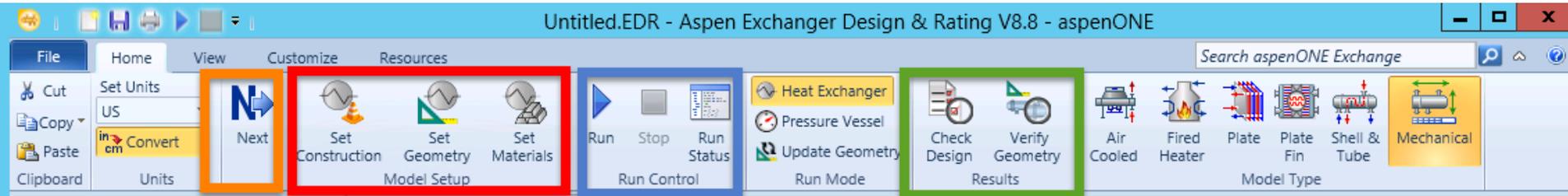
The "File" menu is open, showing the following options: Exchange, New, Open..., Close, Save, Save As, Add, Delete, Import, Export, Recent, Print, Print Setup, About, Options, and Exit. The "New" option is highlighted with a red circle labeled "2".

The "New" submenu is open, showing a list of exchanger types. The "Shell & Tube Mechanical" option is selected with a checkmark and highlighted with a red circle labeled "3". Other options include Shell & Tube, Plate, Plate Fin, Air Cooled, Fired Heater, Budget Cost Est, Comp Mech Design, Metals, Properties For Chemical, and Tubesheet Layout.

A red circle labeled "4" points to the "Create" button at the bottom of the "New" submenu.

A blue banner at the bottom of the screenshot contains the text "Open Aspen Exchanger Design & Rating V8.8."

Home Ribbon Work Flow



‘HOME RIBBON’ guides sequentially through the various stages of the heat exchanger design.

NEXT button takes us sequentially through the required input forms to complete the program inputs.

MODEL SETUP contains shortcuts to the main input forms.

RUN CONTROL contains key to run the design calculations.

RESULTS provides easy access to key results.

Set the Program for Heat Exchanger Design

Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

Search aspenONE Exchange

Heat Exchanger

EDR Navigator

Shell & Tube Mech

Design Specifications

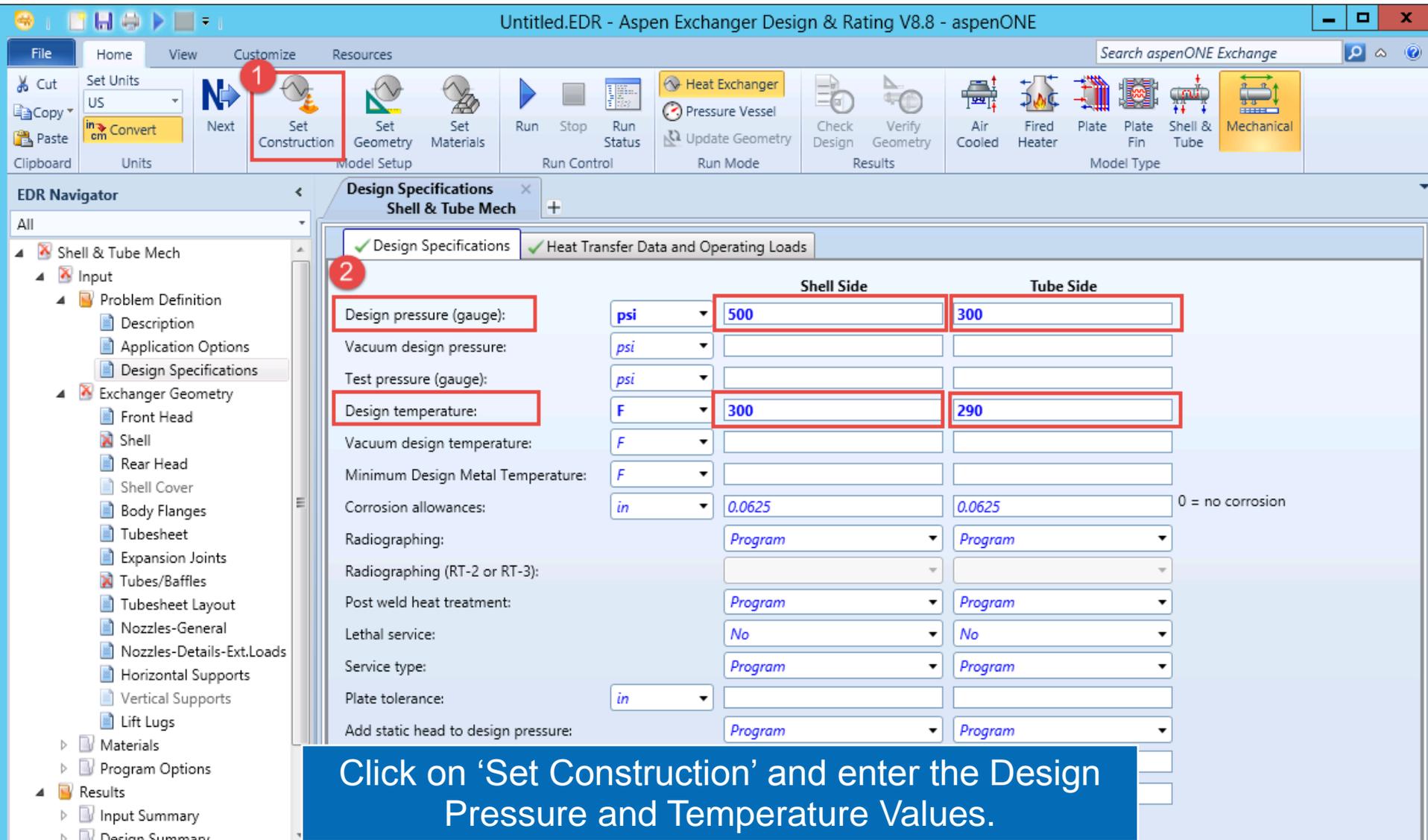
Heat Transfer Data and Operating Loads

	Shell Side	Tube Side
Design pressure (gauge):	psi	
Vacuum design pressure:	psi	
Test pressure (gauge):	psi	
Design temperature:	F	
Vacuum design temperature:	F	
Minimum Design Metal Temperature:	F	
Corrosion allowances:	in	0.0625
Radiographing:	Program	Program
Radiographing (RT-2 or RT-3):		
Post weld heat treatment:	Program	Program
Lethal service:	No	No
Service type:	Program	Program
Plate tolerance:	in	
Add static head to design pressure:	Program	Program

0 = no corrosion

On the Home Ribbon, confirm that the run mode is set to 'Heat Exchanger'.

Specify the Design Temperature and Pressure



Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

Search aspenONE Exchange

File Home View Customize Resources

Clipboard Units Model Setup Run Control Run Mode Results Model Type

EDR Navigator

Design Specifications Shell & Tube Mech

Design Specifications Heat Transfer Data and Operating Loads

	Shell Side	Tube Side
Design pressure (gauge):	psi 500	300
Vacuum design pressure:	psi	
Test pressure (gauge):	psi	
Design temperature:	F 300	290
Vacuum design temperature:	F	
Minimum Design Metal Temperature:	F	
Corrosion allowances:	in 0.0625	0.0625
Radiographing:	Program	Program
Radiographing (RT-2 or RT-3):		
Post weld heat treatment:	Program	Program
Lethal service:	No	No
Service type:	Program	Program
Plate tolerance:	in	
Add static head to design pressure:	Program	Program

0 = no corrosion

Click on 'Set Construction' and enter the Design Pressure and Temperature Values.

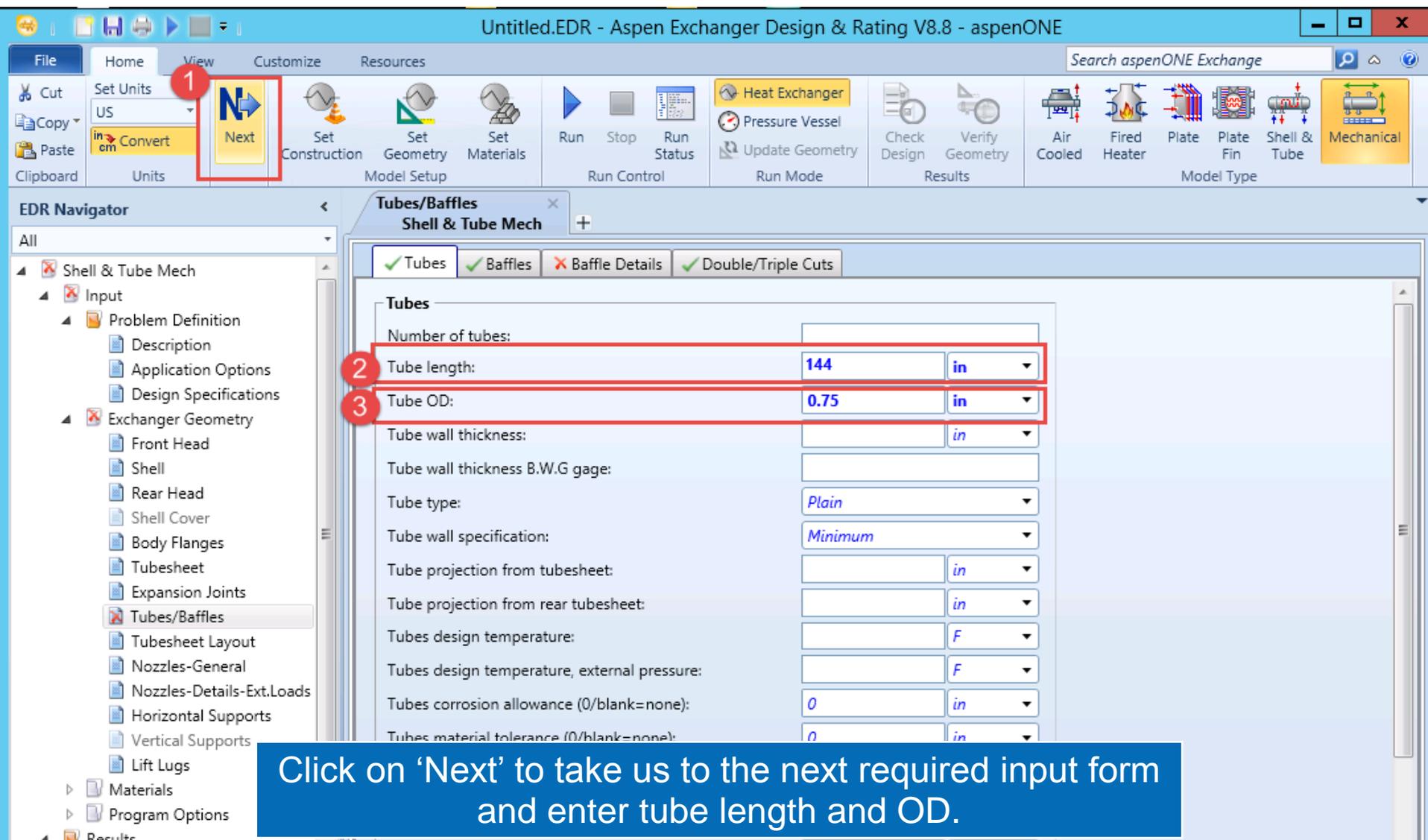
Specify Shell Geometry

The screenshot displays the Aspen Exchanger Design & Rating V8.8 software interface. The title bar reads "Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE". The ribbon menu includes tabs for File, Home, View, Customize, and Resources. The "Set Geometry" icon is highlighted with a red box and a circled "1". The "EDR Navigator" on the left shows a tree view with "Shell & Tube Mech" expanded, and "Shell" selected. The main workspace shows the "Shell & Tube Mech" configuration panel with tabs for Shell, Shell Cylinder, Kettle Cylinder, Kettle Reducer/Weir, and Vapor Belt. The "Shell" tab is active, showing the following settings:

- Shell type: *E - one pass shell*
- Exchanger (vessel) position: *Horizontal*
- Shell outside diameter: [] in
- Shell inside diameter: *40* in

The "Horizontal" position and "40" inside diameter are highlighted with red boxes and circled "2" and "3" respectively. A 3D model of a horizontal shell and tube exchanger is shown on the right. A blue callout box at the bottom contains the text: "Click on 'Set Geometry' and Specify Shell position and Inside Diameter."

Specify Tube Geometry



Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

File Home View Customize Resources

Search aspenONE Exchange

Clipboard Units Model Setup Run Control Run Mode Results Model Type

EDR Navigator

All

Shell & Tube Mech

Input

Problem Definition

Description

Application Options

Design Specifications

Exchanger Geometry

Front Head

Shell

Rear Head

Shell Cover

Body Flanges

Tubesheet

Expansion Joints

Tubes/Baffles

Tubesheet Layout

Nozzles-General

Nozzles-Details-Ext.Loads

Horizontal Supports

Vertical Supports

Lift Lugs

Materials

Program Options

Results

Tubes/Baffles Shell & Tube Mech

Tubes Baffles Baffle Details Double/Triple Cuts

Tubes

Number of tubes:

Tube length: 144 in

Tube OD: 0.75 in

Tube wall thickness: in

Tube wall thickness B.W.G gage:

Tube type: Plain

Tube wall specification: Minimum

Tube projection from tubesheet: in

Tube projection from rear tubesheet: in

Tubes design temperature: F

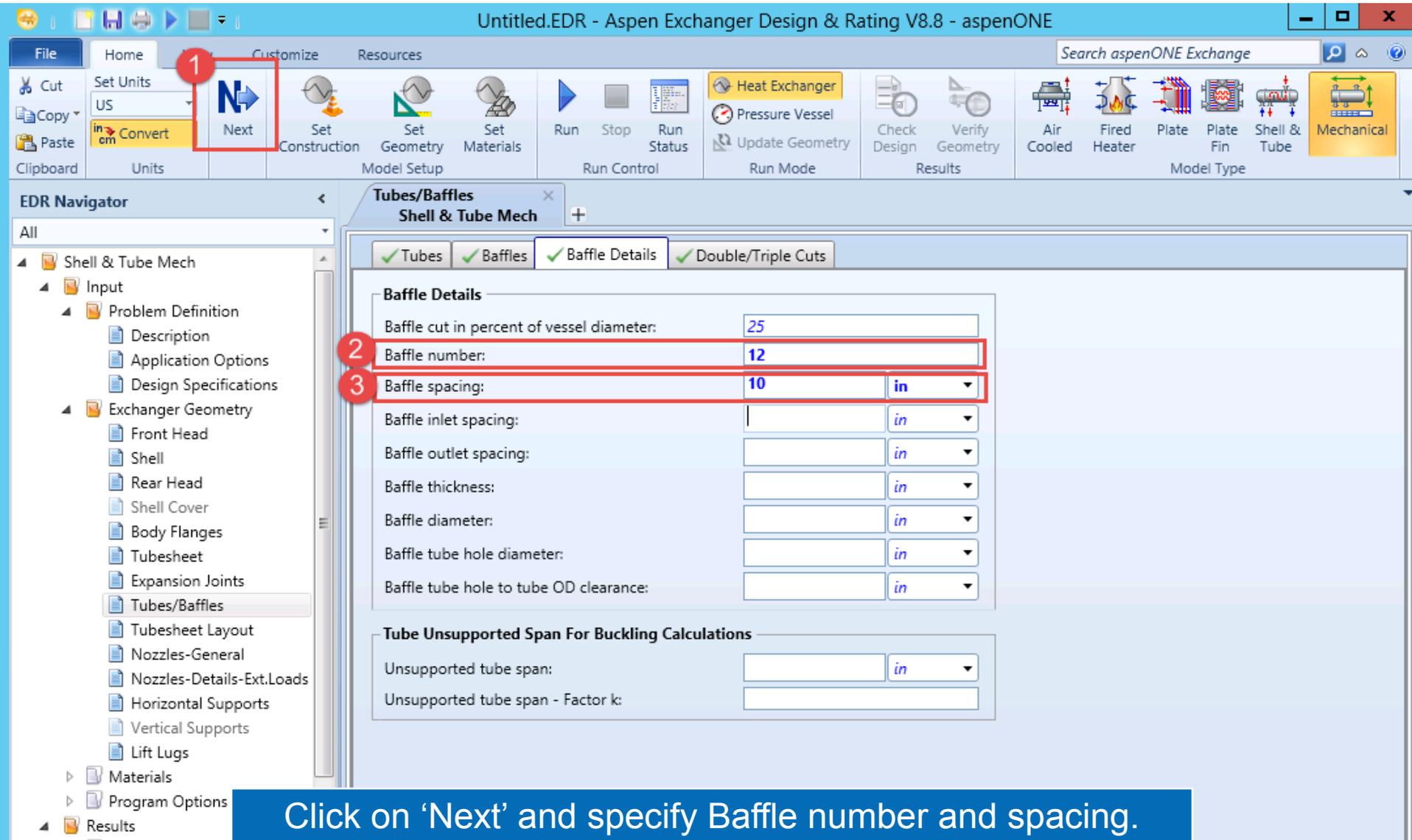
Tubes design temperature, external pressure: F

Tubes corrosion allowance (0/blank=none): 0 in

Tubes material tolerance (0/blank=none): 0 in

Click on 'Next' to take us to the next required input form and enter tube length and OD.

Specify Baffle Details



Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

File Home Customize Resources Search aspenONE Exchange

Clipboard Units Model Setup Run Control Run Mode Results Model Type

EDR Navigator

- All
- Shell & Tube Mech
 - Input
 - Problem Definition
 - Description
 - Application Options
 - Design Specifications
 - Exchanger Geometry
 - Front Head
 - Shell
 - Rear Head
 - Shell Cover
 - Body Flanges
 - Tubesheet
 - Expansion Joints
 - Tubes/Baffles**
 - Tubesheet Layout
 - Nozzles-General
 - Nozzles-Details-Ext.Loads
 - Horizontal Supports
 - Vertical Supports
 - Lift Lugs
 - Materials
 - Program Options
 - Results

Tubes/Baffles Shell & Tube Mech

✓ Tubes ✓ Baffles ✓ Baffle Details ✓ Double/Triple Cuts

Baffle Details

Baffle cut in percent of vessel diameter: 25

Baffle number: 12

Baffle spacing: 10 in

Baffle inlet spacing: in

Baffle outlet spacing: in

Baffle thickness: in

Baffle diameter: in

Baffle tube hole diameter: in

Baffle tube hole to tube OD clearance: in

Tube Unsupported Span For Buckling Calculations

Unsupported tube span: in

Unsupported tube span - Factor k:

Click on 'Next' and specify Baffle number and spacing.

Specify Nozzle Details

The screenshot displays the Aspen Exchanger Design & Rating V8.8 software interface. The title bar reads "Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE". The ribbon menu includes options like "Heat Exchanger", "Pressure Vessel", "Update Geometry", "Check Design", "Verify Geometry", "Air Cooled", "Fired Heater", "Plate", "Plate Fin", "Shell & Tube", and "Mechanical".

The "EDR Navigator" on the left shows a tree view with "Nozzles-General" selected under "Shell & Tube Mech". A red circle with the number "1" highlights the "Exchanger Geometry" folder, and a red circle with the number "2" highlights the "Nozzles-General" folder.

The "Nozzles-General" panel shows a table of nozzle specifications. A red circle with the number "3" highlights the "Nozzles" tab, and a red circle with the number "4" highlights the table. The table contains the following data:

Name	Description	Function	OD/Nom. in	ID in	Location	Angle Degrees
T1		Inlet		8	2	180
T2		Outlet		8	2	0
S1		Inlet		6	7	0
S2		Outlet		6	3	180

To the right of the table is a diagram of a shell and tube heat exchanger with numbered nozzles (1-9) and a circular view showing nozzle angles (0, 45, 90, 135, 180, 225, 270, 315, 360 degrees).

In order to run an initial design, nozzle data is not a required input. However for this exercise we do know the details of the nozzles and hence these can be specified.

Set Materials

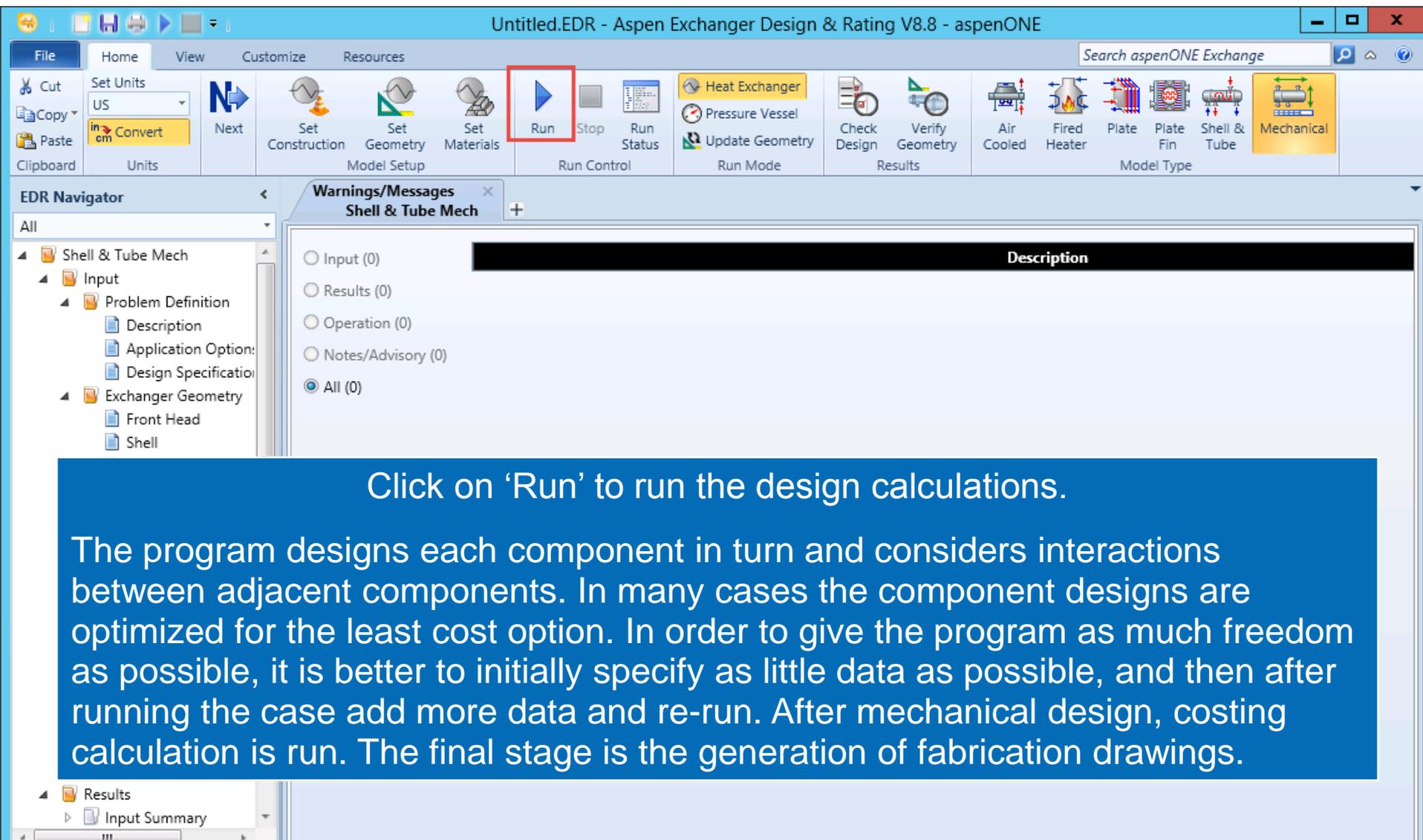
The screenshot displays the Aspen Exchanger Design & Rating V8.8 software interface. The title bar reads "Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE". The ribbon contains several tabs, with "Set Materials" highlighted in a red box. The "EDR Navigator" on the left shows a tree view with "Materials" expanded to "Main Materials". The main window shows a table of material specifications for a "Shell & Tube Mech" design.

Component	Material	
Supports material	Carbon Steel	1
Front head cover material	Carbon Steel	1
Front head cylinder material	Carbon Steel	1
Flange at front tubesheet - material	Carbon Steel	1
Flange at front tubesheet - bolting material	Carbon Steel	1
Flange at front tubesheet - gasket material	Carbon Steel	1
Shell cylinder material	Carbon Steel	1
Baffle material	Carbon Steel	1
Tube material	Carbon Steel	1
Tubesheet material	Carbon Steel	1
Rear tubesheet material	Carbon Steel	1
Rear head cover material	Carbon Steel	1
Flange at rear tubesheet - material	Carbon Steel	1
Flange at rear tubesheet - bolting material	Carbon Steel	1
Flange at rear tubesheet - gasket material	Carbon Steel	1

Search Databank

Click on 'Set Materials'. In this example, default materials have been used. When performing a mechanical design, careful consideration is required of the material types and the product forms that are selected.

Run Design



Click on 'Run' to run the design calculations.

The program designs each component in turn and considers interactions between adjacent components. In many cases the component designs are optimized for the least cost option. In order to give the program as much freedom as possible, it is better to initially specify as little data as possible, and then after running the case add more data and re-run. After mechanical design, costing calculation is run. The final stage is the generation of fabrication drawings.

View Overall Dimensions

The screenshot shows the Aspen Exchanger Design & Rating V8.8 software interface. The title bar reads "Untitled.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE". The ribbon includes tabs for File, Home, View, Customize, and Resources. The "Check Design" button is highlighted with a red box. The EDR Navigator on the left shows a tree view with "Overall Dim/Fitting Loc/Misc Shell & Tube Mech" selected. The main window displays the "Overall Dimensions" table.

Overall Dimensions			Overall length	
Major components				
Overall Front Head Assembly			36.1875	in
Front Tubesheet			2	in
	Tubesheet Thickness	2.1875 in		
	Tube Side Recess	in		
	Shell Side Recess	0.1875 in		
	Welding Stub End(s)	in		
	Clad Thickness	in		
Shell			139.75	in
Rear Tubesheet			2	in
	Tubesheet Thickness	2.1875 in		
	Tube Side Recess	in		
	Major components	0.1875 in		
	Welding Stub End(s)	in		
	Clad Thickness	in		
Overall Rear Head Assembly			32.1875	in
Overall Shell Cover Assembly				in
Unit Overall Length			212.125	in

Click on 'Check Design' to view the overall dimensions.

View Setting Plan

JG-S&T.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

File Home View Customize Resources Search aspenONE Exchange

Cut Copy Paste Set Units US Convert Next Set Construction Set Geometry Set Materials Run Stop Run Status Heat Exchanger Pressure Vessel Update Geometry Check Design Verify Geometry Air Cooled Fired Heater Plate Plate Fin Shell & Tube Mechanical

EDR Navigator

Setting Plan Shell & Tube Mech

Mechanical Setting Plan Materials of Construction Thermal Setting Plan

Shell & Tube Mech

Input

- Problem Definition
 - Description
 - Application Options
 - Design Specifications
- Exchanger Geometry
- Materials
- Program Options

Results

- Input Summary
- Design Summary
 - Warnings/Messages
 - Design Specifications/
 - Overall Dim/Fitting Lo
 - MAWP/MDMT/Test/Pl
- Vessel Dimensions
- Price
- Drawings
 - Setting Plan
 - Tubeheet Layout
 - All Drawings
- Code Calculations

Nozzles (1)				Couplings / Support (2)				Design Specifications		Shell	Tube	Company:	
Label	Size	Designation	Flange	Label	Size	Designation	Flange	Design Pressure	psig	500	300	License:	Service of Client:
TI	8"	300	ASME Class 150	CC1	3"	ASME Class 150	ASME Class 150	100	100	450	300		

Click on 'Verify Geometry' to view setting plan drawings.

View Cost Estimate

JG-S&T.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE

Search aspenONE Exchange

File Home View Customize Resources

Clipboard: Cut, Copy, Paste

Units: Set Units (US), Convert

Model Setup: Set Construction, Set Geometry, Set Materials

Run Control: Run, Stop, Run Status

Run Mode: Heat Exchanger, Pressure Vessel, Update Geometry

Results: Check Design, Verify Geometry

Model Type: Air Cooled, Fired Heater, Plate, Plate Fin, Shell & Tube, Mechanical

EDR Navigator

- All
- Shell & Tube Mech
 - Input
 - Problem Definition
 - Description
 - Application Options
 - Design Specifications
 - Exchanger Geometry
 - Materials
 - Program Options
 - Results
 - Input Summary
 - Design Summary
 - Warnings/Messages
 - Design Specifications/Materials
 - Overall Dim/Fitting Loc/Misc
 - MAWP/MDMT/Test/PWHT
 - Vessel Dimensions
 - Price
 - Cost Estimate**
 - Bill of Materials
 - Labor Details
 - Drawings
 - Setting Plan
 - Tubesheet Layout
 - All Drawings

Cost Estimate Shell & Tube Mech

Cost Estimate | Material and Labor Details | Final Assembly

Cost Estimate				
Material (except tubing)				16630
Tubing Material	18648 ft	0.79 / ft		14786
Total labor	871.0495 hrs at	60 per hr		52263
Mark-up on material	20 Percent			3326
Mark-up on tubing	10 Percent			1479
Mark-up on labor	20 Percent			10453
Selling Price		Dollar(US)		98936

View Code Calculations

Software interface for Aspen Exchanger Design & Rating V8.8 - aspenONE. The window title is "JG-S&T.EDR - Aspen Exchanger Design & Rating V8.8 - aspenONE".

The interface includes a ribbon menu with tabs: File, Home, View, Customize, Resources. The ribbon contains various tool groups such as Clipboard, Units, Next, Model Setup, Run Control, Run Mode, Results, and Model Type.

The EDR Navigator on the left shows a tree view with the following items:

- All
- Shell & Tube Mech
 - Input
 - Results
 - Input Summary
 - Design Summary
 - Vessel Dimensions
 - Price
 - Drawings
 - Code Calculations
 - Cylinders/Covers
 - Body Flanges
 - Tubesheets/Expansion Joints
 - Nozzles
 - Supports
 - Wind/Seismic/Weights/Ins
 - Lift Lugs
 - MAWP/MDMT/Test P/Static P

The main window displays the "Tubesheets/Expansion Joints" section, specifically "Shell & Tube Mech". The "Find What:" field is empty. The content area shows the following text:

```

Component: Tubesheets      Rules for the Design of Fixed Tubesheets
ASME VIII-1 2013 UHX-13 Fig.UHX-13.1(b) Controlling Case: UHX-13.4(a)(3)

*** Tubesheet material:   SA-516 K02700 Grd 70 Plate
Tubesheet temperature T = 300 F      TubSh metal tmp at rim T' = 300 F
TubSh allowable stress S = 20000 psi  *TubSh th.ex.coe.alpha = 6.9
TubSh mod.elasticity E = 28100000 psi *TubSh th.ex.coe.alpha' = 6.9
Poisson's rat. tubSh v = 0.3         *(th.exp.coef * 10**6)

*** Shell material:       SA-516 K02700 Grd 70 Plate
Design temp. shell Ts = 300 F        Shell metal tmp/TubS T's = 300 F
Shell allowable str. Ss = 20000 psi   *Shell th.ex.coe.alpha's = 6.9
Shell mod.elasticity Es = 28100000 psi Shell mean metal tmp Tsm = 300 F
Poisson's ratio shell vs = 0.3       *Shell th.ex.coe.alphasm = 6.9

*** Tube material:        SA-214 K01807 Wld. tube
Design temp. tubes Tt = 300 F        Tubes mean metal tmp Ttm = 290 F
Tube allow.Str. at Tt St = 13412 psi  Tube allow.Str. at T Stt = 13412 psi
Tube mod.elas. at Tt Et = 28100000 psi Tube mod.elas. at T Ett = 28100000 psi
Poisson's rat. tubes vt = 0.3        *Tube th.ex.coe.alphatm = 6.88
Tube yield stress Syt = 23000 psi     *(th.exp.coef * 10**6)

*** Channel material:     SA-516 K02700 Grd 70 Plate
Design temp. channel Tc = 290 F      Channel metal tmp TS T'c = 290 F
Channel all. stress Sc = 20000 psi   *Chan.th.ex.coe.alpha'c = 6.88
Channel mod.elast. Ec = 28150000 psi *(th.exp.coef * 10**6)
Poisson's rat.channel vc = 0.3

*** Adjacent shell matl:  -
Adj Shell all. str. Ss,1 = -         *Shell th.ex.coe.alpha's1= 0.0
                                       *Shell th.ex.coe.alpha'sm1=0.0

Tubesheet thickness h = 2.1875 in    Actual tubesheet thk ha = 2.1875 in

Shell side corr allow c = 0.0625 in  Tube side cor.allow. c = 0.0625 in
    
```

Copy Results to Other Formats

Export results to Word, Excel or Inventor file format.

- Excel using default template
- Excel using specified template
- Inventor
- Word

Export

Print

Print Setup

About

Copy results tables to clipboard.

Nozzle description		T1	T2	S1	S2
Nozzle designator		Tube	Tube	Shell	Shell
Vessel side		Tube	Shell	Shell	
Outside diameter	in	8.625	8.625	6.625	6.625
Inside diameter	in	7.813	7.813	5.761	5.761
Calculated thickness	in	0.1884			
Code minimum thk	in	0.395			
Actual thickness	in	0.406			
Nozzle weld leg	in	0.25	0.25	0.3695	0.3695
Reinf.pad OD	in	14.125	14.125	10.875	10.875
Reinf.pad thickness	in	0.25	0.25	0.375	0.375

Copy
Copy with Description
Ctrl+C

Copy
Print
Export to DXF
Zoom In
Zoom Out

Copy drawings to clipboard or save as 'dxf' file.

Additional Resources & Contacts

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

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