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

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

On the Home Ribbon, confirm that the run mode is set to ‘Heat Exchanger’.
Specify the Design Temperature and Pressure

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

**Design Specifications**

- **Shell Side**
  - Design pressure (gauge): 500 psi
  - Test pressure (gauge): 300 psi
  - Design temperature: 300°F
  - Vacuum design temperature: 
  - Minimum Design Metal Temperature: 0.0625 in

- **Tube Side**
  - Design pressure (gauge): 300 psi
  - Test pressure (gauge): 
  - Design temperature: 200°F
  - Vacuum design temperature: 
  - Minimum Design Metal Temperature: 0.0625 in

0 = no corrosion
Specify Shell Geometry

Click on ‘Set Geometry’ and Specify Shell position and Inside Diameter.
Specify Tube Geometry

Click on ‘Next’ to take us to the next required input form and enter tube length and OD.
Specify Baffle Details

Click on ‘Next’ and specify Baffle number and spacing.

Baffle Details
- Baffle cut in percent of vessel diameter: 25
- Baffle number: 12
- Baffle spacing: 10 in
- Baffle inlet spacing:
- Baffle outlet spacing:
- Baffle thickness:
- Baffle diameter:
- Baffle tube hole diameter:
- Baffle tube hole to tube OD clearance:

Tube Unsupported Span For Buckling Calculations
- Unsupported tube span:
- Unsupported tube span - Factor k:
Specify Nozzle Details

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.
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

Click on ‘Check Design’ to view the overall dimensions.
Click on ‘Verify Geometry’ to view setting plan drawings.
### Cost Estimate

<table>
<thead>
<tr>
<th>Material/Operation</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material (except tubing)</td>
<td></td>
<td></td>
<td>16630</td>
</tr>
<tr>
<td>Tubing Material</td>
<td>18648 ft</td>
<td></td>
<td>14738</td>
</tr>
<tr>
<td>Total labor</td>
<td>871.0495</td>
<td>hrs at 60 per hr</td>
<td>52233</td>
</tr>
<tr>
<td>Mark-up on material</td>
<td>20</td>
<td>Percent</td>
<td>3326</td>
</tr>
<tr>
<td>Mark-up on tubing</td>
<td>10</td>
<td>Percent</td>
<td>1479</td>
</tr>
<tr>
<td>Mark-up on labor</td>
<td>20</td>
<td>Percent</td>
<td>10453</td>
</tr>
<tr>
<td>Selling Price</td>
<td></td>
<td>Dollar(US)</td>
<td>98936</td>
</tr>
</tbody>
</table>

**Notes:**
- The cost estimate includes material costs and labor costs.
- The table shows the cost breakdown for different components and operations.
- The selling price is calculated after adding mark-ups on material, tubing, and labor.
View Code Calculations

Component: Tubesheets

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

*** Tube sheet material: SA-516 Gr 70 Plate

Tubesheet Temperature T = 300 F

Tubsh allowable stress S = 20000 psi

Tubsh mod.elasticity E = 2810000 psi

Poisson's rat. tubsh V = 0.3

(th.exp.coef = 10^6)

*** Shell material: SA-516 Gr 70 Plate

Design temp. shell Ts = 300 F

Shell allowable str. Ss = 20000 psi

Shell mod.elasticity Es = 2810000 psi

Poisson's ratio shell vs = 0.3

*** Tube material: SA-214 K01807 Weld. tube

Design temp. tubes Tt = 300 F

Tube allow. Str. at Tt St = 13412 psi

Tube mod.elas. at Tt Et = 2810000 psi

Poisson's rat. tubes vt = 0.3

Tube yield stress Syt = 23000 psi

(th.exp.coef = 10^6)

*** Channel material: SA-516 Gr 70 Plate

Design temp. channel Tc = 200 F

Channel allow. Str. at Tc Sc = 20000 psi

Channel mod.elas. Ec = 2810000 psi

Poisson's rat. channel vc = 0.3

*** Adjacent shell matl:

Shell allow. str. Ss,1 = 0.0

Shell mod.elast. Ec = 2810000 psi

Poisson's rat. channel vc = 0.3

Tubesheet thickness h = 2.1875 in

Actual tubesheet thk ha = 2.1875 in

Shell side corr.allow c = 0.0625 in

Tube side corr.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

Copy results tables to clipboard.

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

<table>
<thead>
<tr>
<th>Contact Name</th>
<th>Contact Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandeep Mohan</td>
<td><a href="mailto:Sandeep.Mohan@aspentech.com">Sandeep.Mohan@aspentech.com</a></td>
</tr>
</tbody>
</table>