



**E-6003
Design and Principles**



Process data

	Shell Side		Tube Side		Units
	Inlet	Outlet	Inlet	Outlet	
Fluids	Process condensate		Cooling water		
Quantity: total	47200		166009		kg/h
liquid	47200	47200	166009	166009	kg/h
gas					kg/h
Operating temperature	100	65	38	48	°C
Operating pressure	1,5		4,5		bar g
Liquid: molecular weight	18,02	18,02	18,02	18,02	kg/kmol
density	958	980	993	989	kg/m ³
viscosity	0,283	0,434	0,681	0,567	cP
specific heat capacity	4,213	4,184	4,175	4,177	kJ/kg/°C
thermal conductivity	0,6768	0,6505	0,6199	0,6323	W/m/°C
boiling temperature	106				°C
Gas: molecular weight					kg/kmol
density					kg/m ³
viscosity					cP
specific heat capacity					kJ/kg/°C
thermal conductivity					W/m/°C
dew point					°C

Heating and Cooling Table

Shell side							
Temperature °C	Gas fraction wt %	Duty profile MW	Liquid density kg/m ³	Liquid viscosity cP	Liquid heat capacity kJ/kg/°C	Liquid thermal conductivity W/m/°C	Surface tension dyn/cm
100	0,00	0,0	958	0,283	4,213	0,6768	58
96	0,00	-0,2	961	0,295	4,209	0,6746	59
92	0,00	-0,4	964	0,307	4,205	0,6723	60
88	0,00	-0,6	966	0,321	4,201	0,6697	60
84	0,00	-0,9	969	0,336	4,197	0,6670	61
81	0,00	-1,1	971	0,352	4,194	0,6641	62
77	0,00	-1,3	974	0,37	4,191	0,6609	63
73	0,00	-1,5	976	0,389	4,189	0,6576	63
69	0,00	-1,7	978	0,411	4,186	0,6541	64
65	0,00	-1,9	980	0,434	4,184	0,6505	65

Tube side							
Temperature °C	Gas fraction wt %	Duty profile MW	Liquid density kg/m ³	Liquid viscosity cP	Liquid heat capacity kJ/kg/°C	Liquid thermal conductivity W/m/°C	Surface tension dyn/cm
48	0,00	0,0	989	0,567	4,177	0,6323	63
47	0,00	0,2	990	0,579	4,176	0,6309	63
46	0,00	0,4	990	0,59	4,176	0,6296	64
45	0,00	0,6	991	0,602	4,176	0,6283	64
44	0,00	0,9	991	0,614	4,176	0,6269	65
42	0,00	1,1	992	0,627	4,175	0,6255	65
41	0,00	1,3	992	0,64	4,175	0,6241	66
40	0,00	1,5	992	0,653	4,175	0,6227	66
39	0,00	1,7	993	0,667	4,175	0,6213	67
38	0,00	1,9	993	0,681	4,175	0,6199	67



Open HTRI and Input Summary sheet and enter data in red areas

Xist - [Input] - For test.htri - Input Summary

Input Summary

Case Mode: Rating Simulation Design

Exchanger Configuration: Exchanger service: **Generic Shell and Tube**

Process Conditions:

Flow rate	Hot Shell	47200	Cold Tube		kg/hr
Inlet/outlet Y	0	/	0	/	0
Inlet/outlet T	100	/	65	/	38 / 48
Inlet P/allow dP	1.5	/	0.1	/	4.5 / 0.6
Fouling resistance	0.00017		0.0003		m ² -K/W

Shell Geometry: TEMA type: **B** | E | M | ID: 300 mm | Orientation: Horizontal | Hot fluid: **Shellside**

Baffle Geometry: Type: Single segmental | Orientation: Perpendicular | Cut: 25 % ID | Spacing: 100 mm

Tube Geometry: Type: Plain | Wall thickness: 1.651 mm | Length: 6.096 m | Layout angle: 30 degrees | Tube OD: 19.05 mm | Tubepasses: 1 | Pitch: 25.4 mm | Tubecount:

Navigation: << Previous Next >>

Bottom Bar: Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00

Xist - [Input] - For test.htri - Input Summary-Geometry

Geometry

Shell Geometry: TEMA type: B | **E** | M | ID: 300 mm | Orientation: **Horizontal** | Hot fluid: Shellside

Baffle Geometry: Type: Single segmental | Orientation: Perpendicular | Cut: 25 % ID | Spacing: 100 mm

Tube Geometry: Type: Plain | Wall thickness: 1.651 mm | Length: 6.096 m | Layout angle: 30 degrees | Tube OD: 19.05 mm | Tubepasses: 1 | Pitch: 25.4 mm | Tubecount:

Navigation: << Previous Next >>

Bottom Bar: Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00



Enter operating data in process sheet in red areas

Parameter	Hot Fluid	Cold Fluid	Units
Fluid name	PC	CW	
Phase	All liquid	All liquid	
Flow rate	47200		kg/hr
Inlet fraction vapor	0	0	weight fraction vapor
Outlet fraction vapor	0	0	weight fraction vapor
Inlet temperature	100	38	C
Outlet temperature	65	48	C
Inlet pressure	1.5	4.5	bar-G
Allowable pressure drop	0.1	0.6	bar
Fouling resistance	0.00017	0.0003	m ² -K/W
Fouling layer thickness			mm
Exchanger duty			MegaWatts
Duty/flow multiplier	1		

Enter heating and cooling table data in hot and cold fluid properties in red areas

Fluid name: PC

Fluid compressibility: []

Physical Property Input Option:

- Mixture properties via grid
- Component by component
- Component and grid properties

Heat Release Input Method:

- User specified
- Specified dew/bubble point
- Program calculated

Composition Units:

- Mass
- Moles

Flash Type:

- Differential
- Integral

Property Options:

Temperature interpolation: Program

Buttons: Property Generator..., Property Worksheet...



Xist - [Input] - For test.htri - Input Summary-Hot Fluid Properties-T & P

Input Summary

- Geometry
 - Shell
 - Reboiler
 - Tubes
 - Tube Pass Arrang
 - Tube Layout
 - Baffles
 - Variable Baffle Sp
 - Clearances
 - Nozzles
 - Nozzle Location
 - Distributors
 - Impingement
 - Optional
- Piping
- Process
- Hot Fluid Properties
 - T & P**
 - Heat Release
 - Property Grid
 - Components
 - Dew/Bubble

Pressure	bar-G	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5
Temperature 1	C	100				
Temperature 2	C	96				
Temperature 3	C	92				
Temperature 4	C	88				
Temperature 5	C	84				
Temperature 6	C	81				
Temperature 7	C	77				
Temperature 8	C	73				
Temperature 9	C	69				
Temperature 10	C	65				
Temperature 11	C					
Temperature 12	C					
Temperature 13	C					
Temperature 14	C					
Temperature 15	C					
Temperature 16	C					
Temperature 17	C					
Temperature 18	C					
Temperature 19	C					
Temperature 20	C					
Temperature 21	C					
Temperature 22	C					
Temperature 23	C					
Temperature 24	C					

Clear All Temperature Data Property Worksheet...

Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00

Xist - [Input] - For test.htri - Input Summary-Hot Fluid Properties-Heat Release

Input Summary

- Geometry
 - Shell
 - Reboiler
 - Tubes
 - Tube Pass Arrang
 - Tube Layout
 - Baffles
 - Variable Baffle Sp
 - Clearances
 - Nozzles
 - Nozzle Location
 - Distributors
 - Impingement
 - Optional
- Piping
- Process
- Hot Fluid Properties
 - T & P
 - Heat Release**
 - Property Grid
 - Components
 - Dew/Bubble

Heat release entered as **Total duty from inlet** based on flow of **47200** kg/hr

Pressure Profile 1 - 1.500, bar-G		
Temperature C	Duty Watts	Weight Fraction Vapor
100.00	0	0
96.00	-200000	0
92.00	-400000	0
88.00	-600000	0
84.00	-900000	0
81.00	-1100000	0
77.00	-1300000	0
73.00	-1500000	0
69.00	-1700000	0
65.00	-1900000	0

Clear All Heat Release Data Property Worksheet...

Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00



Xist - [Input] - For test.htri - Input Summary-Hot Fluid Properties-Property Grid

Input Summary

- Geometry
 - Shell
 - Reboiler
 - Tubes
 - Tube Pass Arrang
 - Tube Layout
 - Baffles
 - Variable Baffle Sp
 - Clearances
 - Nozzles
 - Nozzle Location
 - Distributors
 - Impingement
 - Optional
- Piping
- Process
- Hot Fluid Properties
 - T & P
 - Heat Release
 - Property Grid**
 - Components
 - Dew/Bubble
- Cold Fluid Properties

Navigation: << Previous Next >>

Property Grid Data:

Liquid Conductivity, W/m-C	
1.500, bar-G	
C	W/m-C
100.00	0.6768
96.00	0.6746
92.00	0.6723
88.00	0.6697
84.00	0.667
81.00	0.664
77.00	0.6609
73.00	0.6576
69.00	0.6541
65.00	0.6505

Property	Required	Complete
Liquid Conductivity	Yes	Yes
Liquid Density	Yes	Yes
Liquid Heat Capacity	Yes	Yes
Liquid Viscosity	Yes	Yes
Liquid Critical Pressure		
Liquid Critical Temperature		
Liquid Enthalpy		
Liquid Latent Heat		
Liquid Lewis Number		
Liquid Surface Tension		
Vapor Conductivity		
Vapor Density		
Vapor Enthalpy		
Vapor Heat Capacity		
Vapor Viscosity		

Buttons: Clear Selected Property, Clear All Properties, Property Worksheet...

Input Reports Graphs Drawings Shells-in-Series Design Session

Xist 6.00



Put shell info in shell sheet in red areas

Note:

1. Initially estimate shell ID between 1.5-3 times tube-side pipeline ID, here it is 6 inch so first estimation would be 12 inch.

The screenshot displays the 'Xist - [Input] - For test.htri - Input Summary-Geometry-Shell' window. The left-hand tree view shows the 'Shell' component selected under the 'Geometry' category, with a red box around it. The main configuration area includes several sections: 'Case Mode' with 'Rating' selected; 'TEMA Type' with 'E' selected; 'Multiple Shells' with 'Number of shells in parallel' and 'Number of shells in series' both set to 1, and a red box around these two dropdowns; 'Shell Inside Diameter' set to 300 mm, with a red box around the input field; 'Shell Orientation' with 'Horizontal' selected; 'Flow Direction' with 'Flow in 1st tubepass' and 'Flow in train' both set to 'Countercurrent', with a red box around these two dropdowns; and 'Hot Fluid Location' with 'Shellside (Outside tubes)' selected. The bottom of the window features a navigation bar with 'Input', 'Reports', 'Graphs', 'Drawings', 'Shells-in-Series', 'Design', and 'Session' tabs, and a status bar showing 'Xist 6.00'.



In Reboiler Sheet do not enter an input

The screenshot shows the 'Xist - [Input] - E-5010.htri - Input Summary-Geometry-Reboiler' window. On the left is a tree view with 'Reboiler' selected and highlighted in red. The main area is titled 'Reboiler Data' and contains several input fields: 'Reboiler type' (a dropdown menu with 'No piping specified' selected and highlighted in red), 'Bundle diameter' (text box), 'Kettle diameter' (text box), 'Liquid level height/bundle diameter' (text box), 'Entrainment ratio' (text box), 'Number of boiling components' (text box), and 'Required liquid static head' (text box). Below these is the 'Inlet Pressure Location' section with three radio buttons: 'At inlet nozzle' (selected), 'At column bottom', and 'At top of bundle'. At the bottom of the window are navigation buttons '<< Previous' and 'Next >>', and a taskbar with icons for 'Input', 'Reports', 'Graphs', 'Drawings', 'Shells-in-Series', 'Design', and 'Session'. The version number 'Xist 6.00' is displayed in the bottom right corner.



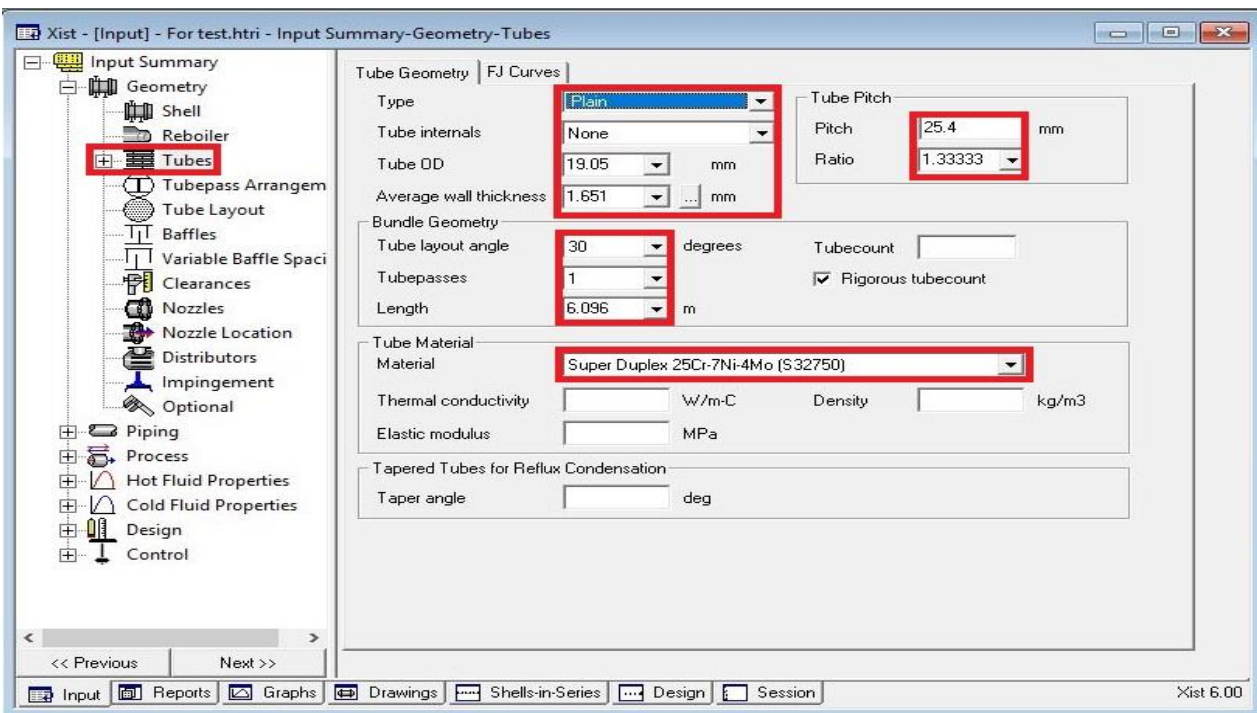
Put Tube mechanical data

Since it is cooling water, 19.05 is selected and thanks to presence of CO₂ and Ammonia in the water Duplex SS is selected.

According to table below tube thickness of 1.65 is chosen.

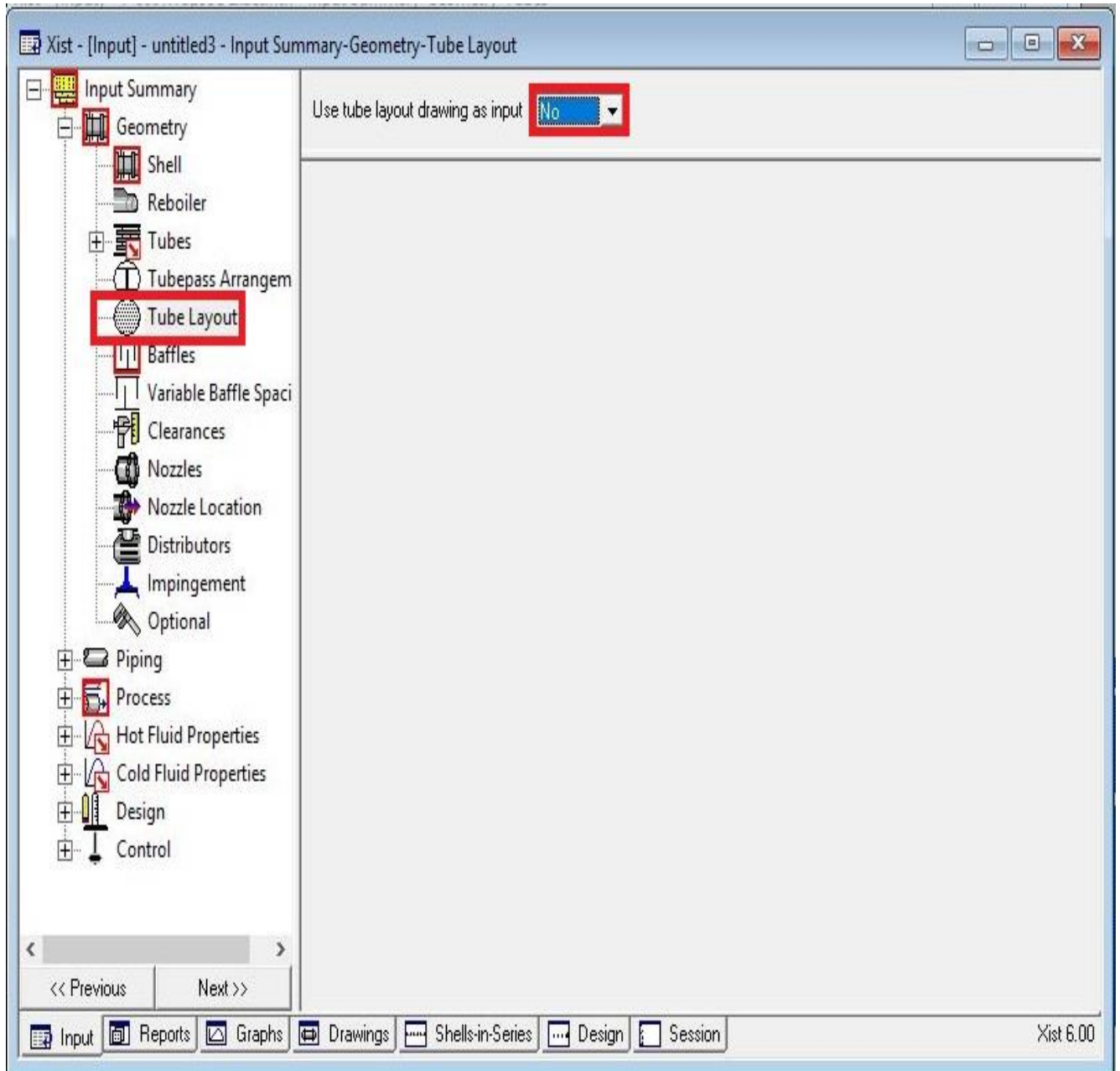
Table 1.3 Typical diameters, thicknesses and pitch arrangement of tubes

Tube outside diameter		mm	15.88	19.05	25.40	31.75
		in	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$
Tube thickness	Carbon and low-alloy steels	mm	1.65	2.11	2.77	3.40
		in	0.065	0.083	0.109	0.134
		b.w.g.	16	14	12	10
	Stainless steels, aluminium, copper and nickel alloys	mm	1.24	1.65	2.11	2.77
		in	0.049	0.065	0.083	0.109
		b.w.g.	18	16	14	12
Minimum tube pitch	Clean service (30° or 60°)	mm	19.84	23.81	31.75	39.69
		in	$\frac{5}{8}$	$\frac{15}{16}$	$1\frac{1}{4}$	$1\frac{5}{16}$
	Fouling service (45° or 90°)	mm	22.22	25.40	31.75	39.69
		in	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{5}{16}$





Act like below





Put baffle info in baffle sheet in red areas like below

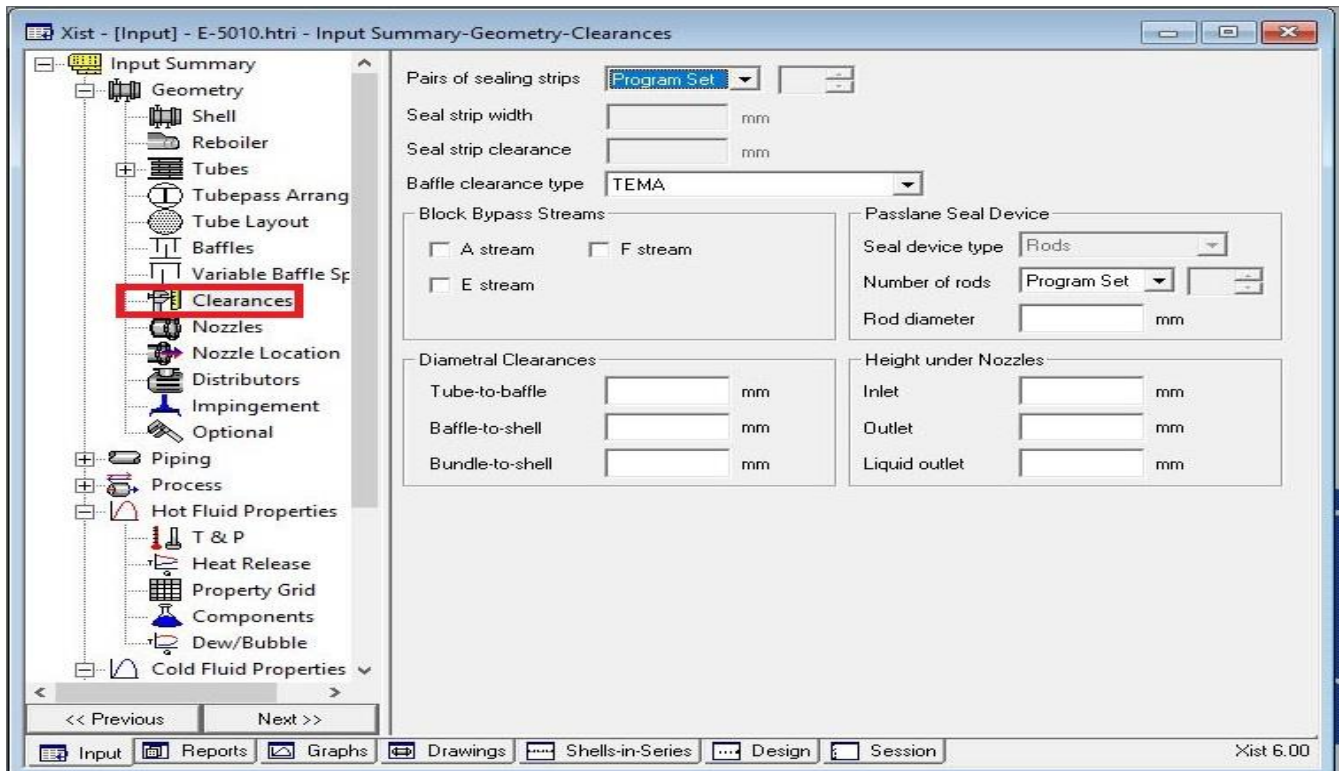
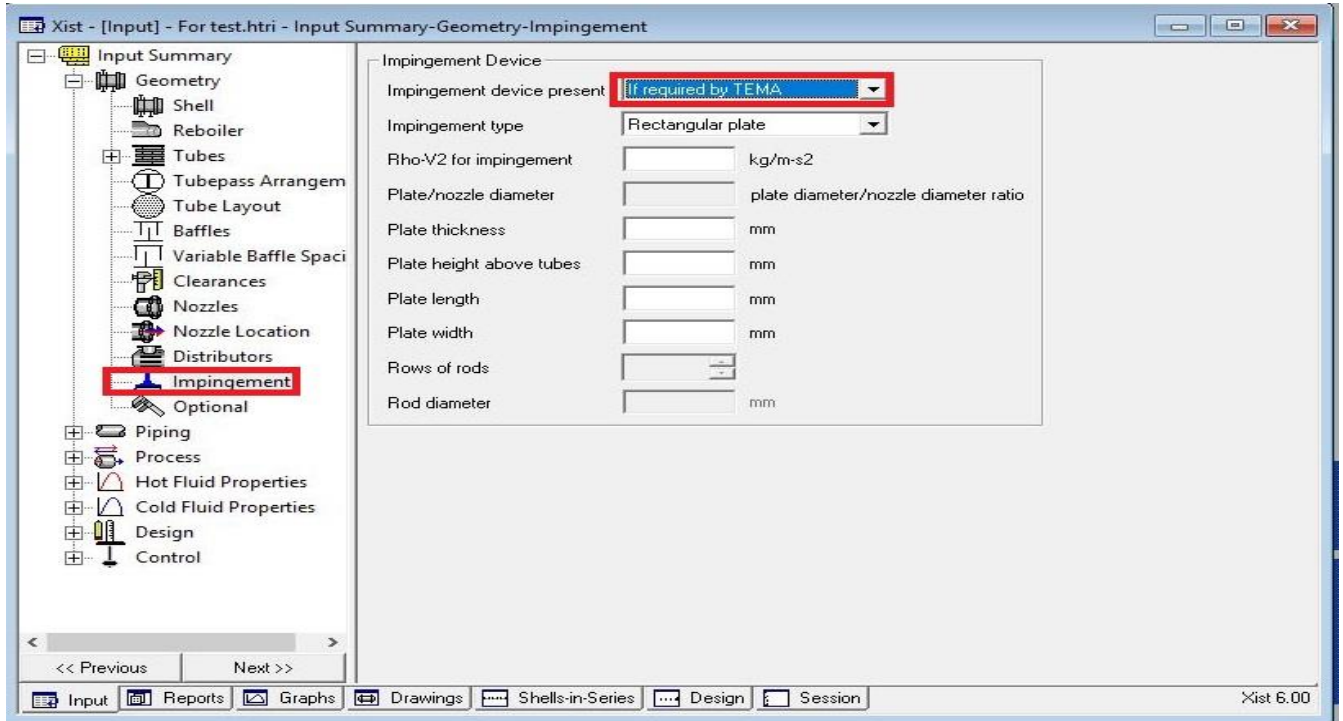
The screenshot shows the 'Input Summary-Geometry-Baffles' window in Xist 6.00. The left sidebar has 'Baffles' selected. The main panel is divided into three sections:

- Baffle Geometry:**
 - Type: Single segmental (highlighted in red)
 - Cut orientation: Program sets (highlighted in red)
 - Cut: 25 (highlighted in red) % of shell ID
 - Window area: [] percent
 - Crosspasses: []
- Baffle Spacing:**
 - Central: 100 (highlighted in red) mm
 - Inlet spacing: [] mm
 - Variable:
 - Outlet spacing: [] mm
- Miscellaneous:**
 - Double-seg. overlap: [] Tuberoes
 - Thickness: [] mm
 - Thickness at tube hole: [] mm
 - Support plates / baffle space: [] []
 - Windows cut from baffles: No
 - Distance from tangent to last baffle: [] mm
 - Rho-V2 for NTIW/ cut design: [] kg/m-s2
 - Central pipe OD: [] mm
 - Helical baffle crossing fraction: []

At the bottom, there are navigation buttons: << Previous, Next >>, and a taskbar with Input, Reports, Graphs, Drawings, Shells-in-Series, Design, and Session. The version number 'Xist 6.00' is in the bottom right corner.



Act exactly like below for impingement sheet and Clearance





Enter nozzle info from piping info

Xist - [Input] - For test.htri - Input Summary-Geometry-Nozzles

Input Summary

- Geometry
 - Shell
 - Reboiler
 - Tubes
 - Tube Pass Arrangement
 - Tube Layout
 - Baffles
 - Variable Baffle Spacing
 - Clearances
 - Nozzles
 - Nozzle Location
 - Distributors
 - Impingement
 - Optional
- Piping
- Process
- Hot Fluid Properties
- Cold Fluid Properties
- Design
- Control

	Shellside	Tubeside
Nozzle standard	02-ANSI_B36_19.TAE	02-ANSI_B36_19.TAE
Nozzle schedule		
Inlet ID	97.181	146.33 mm
Number at each position	1	1
Outlet ID	97.181	146.33 mm
Number at each position	1	1
Liquid outlet ID		
Inlet type		Radial
Outlet type		Same as inlet

Shellside Nozzle Locations

Radial position on shell of inlet nozzle	Top
Longitudinal position on shell of inlet nozzle	At rear head
Radial position on shell of outlet nozzle	Opposite side
Location of nozzle at U-bend	At U-bend

<< Previous Next >>

Input Reports Graphs Drawings Shells-in-Series Design Session

Xist 6.00



Set nozzle location

The screenshot displays the 'Nozzle Location' configuration window in the Xist software. The window title is 'Xist - [Input] - For test.htri - Input Summary-Geometry-Nozzle Location'. The left sidebar shows a tree view with 'Nozzle Location' selected. The main area contains configuration options for Shellside Positions, Tubeside Positions, Front Head, and Tubeside Process. A 3D model of a horizontal vessel is shown with red and blue arrows indicating flow directions.

Section	Parameter	Value
Shellside Positions	Inlet radial	Top
	Inlet longitudinal	Rear head
	Outlet radial	Opposite side
Tubeside Positions	Inlet position	Front head
	Inlet type	Radial
Tubeside Positions	Outlet type	Same as inlet
	Tubeside Process	Type: All liquid
Front Head	Location	[Dropdown]
TEMA Type	[B] [E] [M]	[B] [E] [M]



Results:

1. Now run and the dp in hot shell side becomes 1.62 bar and oversize factor becomes -22%
2. Now increase the shell ID and oversize factor becomes 35% and dp reduces to 0.89 bar
3. Now increase baffle spacing to 250 mm and run it again. Dp reduces to 0.215 and oversize factor to 33%.

Spacing	Oversizing
100	35
250	33
300	31
350	31
400	30.5

4. Now decrease tube length to 4.87 to reduce oversize factor and run it and oversizing factor becomes 5.54%. As a result, dp also reduces to 10.17
5. Now increase Shell ID to 450mm and reduce Tube length to 4.27m simultaneously and the result is that dp becomes 0.138 bar and oversize factor 14%



6. Now increase Shell ID to 500 mm and activate tube layout and run it and the overdiseign factor becomes 40%

Xist - [Input] - For test.htri - Input Summary-Geometry-Tube Layout

Use tube layout drawing as input Yes

TEMA type		BEM
Shell diameter	500.000 mm	
Outer tube limit	484.641 mm	
Height under inlet nozzle	20.505 mm	
Height under outlet nozzle	20.505 mm	
Tube type	Plain	
Tube diameter	19.050 mm	
Tube pitch	25.400 mm	
Tube layout angle	30	
Number of tubes (specified)	307	
Number of tubes (calculated)	307	
Number of tie rods	6	
Number of seal strip pairs	0	
Number of passes	1	
Perpendicular passlane width	15.875 mm	
Baffle cut % diameter	25	

TUBEPASS DETAILS			
Pass	Rows	Tubes	Plugged
1	21	313	0

SYMBOL LEGEND

- Tube
- ⊗ Plugged tube
- Tie rod
- ⊙ Impingement rod
- ⊕ Dummy tube
- Seal rod
- Seal strip/Skid bar

97.1806 mm

97.1806 mm

<< Previous Next >>

Input Reports Graphs Drawings Shells-in-Series Design Session

Xist 6.00



7. Now omit some tube like below and run it and the overdesign becomes 21%

Use tube layout drawing as input: Yes

TEMA type		BEM
Shell diameter		500.000 mm
Duter tube limit		453.085 mm
Height under inlet nozzle		42.502 mm
Height under outlet nozzle		42.502 mm
Tube type		Plain
Tube diameter		19.050 mm
Tube pitch		25.400 mm
Tube layout angle		30
Number of tubes (specified)		259
Number of tubes (calculated)		259
Number of tie rods		6
Number of seal strip pairs		0
Number of passes		1
Perpendicular passlane width		15.875 mm
Baffle cut % diameter		25

TUBEPASS DETAILS			
Pass	Rows	Tubes	Plugged
1	19	265	0

SYMBOL LEGEND

- Tube
- ⊗ Plugged tube
- Tie rod
- ⊙ Impingement rod
- ⊕ Dummy tube
- Seal rod
- Seal strip/Skid bar

But after doing so, the water velocity in tube side reaches less than 1 m/s so we try to use double pass and by doing so, dp in tube side goes from 0.11 to 0.39 bar and tube side h goes from 5426 to 9898 and the velocity goes from 0.98 to 2.11.



8. Now omit some tubes like below and run it and overdesign factor becomes 7%

Use tube layout drawing as input

TEMA type	BEM
Shell diameter	500.000 mm
Outer tube limit	419.046 mm
Height under inlet nozzle	47.036 mm
Height under outlet nozzle	47.036 mm
Tube type	Plain
Tube diameter	19.050 mm
Tube pitch	25.400 mm
Tube layout angle	30
Number of tubes (specified)	212
Number of tubes (calculated)	212
Number of tie rods	6
Number of seal strip pairs	0
Number of passes	2
Perpendicular passlane width	15.875 mm
Baffle cut % diameter	25

TUBEPASS DETAILS			
Pass	Rows	Tubes	Plugged
1	9	109	0
2	9	109	0

SYMBOL LEGEND

- Tube
- ⊗ Plugged tube
- Tie rod
- ⊙ Impingement rod
- ⊕ Dummy tube
- Seal rod
- Seal strip/Skid bar

Now the only fly in the ointment is that B stream is low so different cut and spacing for baffle is tested and baffle cut of 35% is tested and the overdesign factor becomes 1.73% and B-stream increase to 50%.



Xist - [Reports] - For test2.htri - Output Summary

Output Summary Page 1

HTRI Released to the following HTRI Member Company:
mekpco
Behrouzi

Xist E Ver. 6.00 8/11/2022 11:05 SN: Vals100+ **MEKPCO Units**

Rating - Horizontal Multipass Flow TEMA BEM Shell With Single-Segmental Baffles
[See Data Check Messages Report for Informative Messages.](#)
[See Runtime Message Report for Informative Messages.](#)

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			PC		CW
Flow rate (kg/hr)			47200.2		166010
Inlet/Outlet Y (Wt. frac vap.)	0.000	0.000		0.000	0.000
Inlet/Outlet T (Deg C)	100.00	65.00		38.00	48.00
Inlet P/Avg (bar-G)	1.500	1.466		4.500	4.252
dP/Allow. (bar)	0.069	0.100		0.497	0.600
Fouling (m2-K/W)		0.000170			0.000300

Exchanger Performance					
Shell h (W/m2-K)	4067.17	Actual U (W/m2-K)		982.99	
Tube h (W/m2-K)	10403.3	Required U (W/m2-K)		966.32	
Hot regime (-)	Sens. Liquid	Duty (MegaWatts)		1.8988	
Cold regime (-)	Sens. Liquid	Area (m2)		53.654	
EMTD (Deg C)	36.6	Overdesign (%)		1.73	

Shell Geometry			Baffle Geometry		
TEMA type (-)	BEM		Baffle type (-)	Single-Seg.	
Shell ID (mm)	500.000		Baffle cut (Pct Dia.)	35.00	
Series (-)	1		Baffle orientation (-)	Perpend.	
Parallel (-)	1		Central spacing (mm)	250.000	
Orientation (deg)	0.00		Crosspasses (-)	15	

Tube Geometry			Nozzles		
Tube type (-)	Plain		Shell inlet (mm)		97.181
Tube OD (mm)	19.050		Shell outlet (mm)		97.181
Length (m)	4.267		Inlet height (mm)		47.036
Pitch ratio (-)	1.3333		Outlet height (mm)		47.036
Layout (deg)	30		Tube inlet (mm)		146.330
Tubecount (-)	212		Tube outlet (mm)		146.330
Tube Pass (-)	2				

Thermal Resistance, %		Velocities, m/s		Flow Fractions	
Shell	24.17	Shellside	0.28	A	0.086
Tube	11.43	Tubeside	2.25	B	0.493
Fouling	52.38	Crossflow	0.30	C	0.307
Metal	12.02	Window	0.30	E	0.114
				F	0.000

Input Reports Graphs Drawings Shells-in-Series Design Session

Xist 6.00



If baffle cut of 25% is selected then B-stream be as low as 41% but overdesign factor is about 7%

Xist - [Reports] - For test2.htri - Output Summary

HTRI **Output Summary** Page 1
Released to the following HTRI Member Company:
mekpco
Behrouzi

Xist E Ver. 6.00 8/11/2022 11:09 SN: Vals100+ **MEKPCO Units**

Rating - Horizontal Multipass Flow TEMA BEM Shell With Single-Segmental Baffles
[See Data Check Messages Report for Informative Messages.](#)
[See Runtime Message Report for Informative Messages.](#)

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			PC		CW
Flow rate (kg/hr)			47200.2		166010
Inlet/Outlet Y (Wt. frac vap.)	0.000	0.000		0.000	0.000
Inlet/Outlet T (Deg C)	100.00	65.00		38.00	48.00
Inlet P/Avg (bar-G)	1.500	1.461		4.500	4.252
dP/Allow. (bar)	0.078	0.100		0.497	0.600
Fouling (m2-K/W)		0.000170			0.000300

Exchanger Performance					
Shell h (W/m2-K)	5172.72	Actual U (W/m2-K)		1036.58	
Tube h (W/m2-K)	10407.5	Required U (W/m2-K)		968.35	
Hot regime (-)	Sens. Liquid	Duty (MegaWatts)		1.8988	
Cold regime (-)	Sens. Liquid	Area (m2)		53.654	
EMTD (Deg C)	36.5	Overdesign (%)		7.05	

Shell Geometry			Baffle Geometry		
TEMA type (-)	BEM		Baffle type (-)	Single-Seg.	
Shell ID (mm)	500.000		Baffle cut (Pct Dia.)	25.00	
Series (-)	1		Baffle orientation (-)	Perpend.	
Parallel (-)	1		Central spacing (mm)	250.000	
Orientation (deg)	0.00		Crosspasses (-)	15	

Tube Geometry			Nozzles		
Tube type (-)	Plain		Shell inlet (mm)		97.181
Tube OD (mm)	19.050		Shell outlet (mm)		97.181
Length (m)	4.267		Inlet height (mm)		47.036
Pitch ratio (-)	1.3333		Outlet height (mm)		47.036
Layout (deg)	30		Tube inlet (mm)		146.330
Tube count (-)	212		Tube outlet (mm)		146.330
Tube Pass (-)	2				

Thermal Resistance, %		Velocities, m/s		Flow Fractions	
Shell	20.04	Shellside	0.25	A	0.143
Tube	12.05	Tubeside	2.25	B	0.419
Fouling	55.24	Crossflow	0.30	C	0.300
Metal	12.67	Window	0.44	E	0.139
				F	0.000

Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00



Now if the baffle cut 35% and increase tube length to 4.87 and run it. This results in overdesign factor of 16% and so reduce the number of tubes till the overdesign factor becomes 10%. Then activate impingement plate and omit some tubes and run it.

Use tube layout drawing as input

97.1806 mm

97.1806 mm

TEMA type BEM
 Shell diameter 500.000 mm
 Outer tube limit 419.447 mm
 Height under inlet nozzle 78.430 mm
 Height under outlet nozzle 90.930 mm
 Tube type Plain
 Tube diameter 19.050 mm
 Tube pitch 25.400 mm
 Tube layout angle 30
 Number of tubes (specified) 192
 Number of tubes (calculated) 192
 Number of tie rods 6
 Number of seal strip pairs 0
 Number of passes 2
 Perpendicular passlane width 15.875 mm
 Baffle cut % diameter 35

TUBEPASS DETAILS

Pass	Rows	Tubes	Plugged
1	7	99	0
2	7	99	0

SYMBOL LEGEND

- Tube
- Plugged tube
- Tie rod
- Impingement rod
- Dummy tube
- Seal rod
- Seal strip/Skid bar

2
1

<< Previous Next >>

Input Reports Graphs Drawings Shells-in-Series Design Session

Xist 6.00



Xist - [Reports] - For test2.htri - Output Summary-Data Check Messages

HTRI **Output Summary** Page 1

Released to the following HTRI Member Company:
mekpco
Behrouzi

Xist E Ver. 6.00 8/11/2022 11:40 SN: Vals100+ **MEKPCO Units**

Rating - Horizontal Multipass Flow TEMA BEM Shell With Single-Segmental Baffles
[See Data Check Messages Report for Informative Messages.](#)
[See Runtime Message Report for Informative Messages.](#)

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			PC		CW
Flow rate	(kg/hr)		47200.2		166010
Inlet/Outlet Y	(Wt. frac vap.)	0.000	0.000	0.000	0.000
Inlet/Outlet T	(Deg C)	100.00	65.00	38.00	48.00
Inlet P/Avg	(bar-G)	1.500	1.467	4.500	4.180
dP/Allow.	(bar)	0.067	0.100	0.641	0.600
Fouling	(m2-K/W)		0.000170		0.000300

Exchanger Performance					
Shell h	(W/m2-K)	4048.31	Actual U	(W/m2-K)	990.32
Tube h	(W/m2-K)	11241.3	Required U	(W/m2-K)	932.25
Hot regime	(-)	Sens. Liquid	Duty	(MegaWatts)	1.8988
Cold regime	(-)	Sens. Liquid	Area	(m2)	55.601
EMTD	(Deg C)	36.6	Overdesign	(%)	6.23

Shell Geometry			Baffle Geometry		
TEMA type	(-)	BEM	Baffle type	(-)	Single-Seg.
Shell ID	(mm)	500.000	Baffle cut	(Pct Dia.)	35.00
Series	(-)	1	Baffle orientation	(-)	Perpend.
Parallel	(-)	1	Central spacing	(mm)	250.000
Orientation	(deg)	0.00	Crosspasses	(-)	17

Tube Geometry			Nozzles		
Tube type	(-)	Plain	Shell inlet	(mm)	97.181
Tube OD	(mm)	19.050	Shell outlet	(mm)	97.181
Length	(m)	4.877	Inlet height	(mm)	78.430
Pitch ratio	(-)	1.3333	Outlet height	(mm)	90.930
Layout	(deg)	30	Tube inlet	(mm)	146.330
Tube count	(-)	192	Tube outlet	(mm)	146.330
Tube Pass	(-)	2			

Thermal Resistance, %		Velocities, m/s		Flow Fractions	
Shell	24.46	Shellside	0.27	A	0.078
Tube	10.66	Tubeside	2.49	B	0.480
Fouling	52.78	Crossflow	0.30	C	0.332
Metal	12.11	Window	0.28	E	0.110
				F	0.000

Navigation: < << Prev Next >> >

Input Reports Graphs Drawings Shells-in-Series Design Session Xist 6.00



Licenser Design

Xist - [Reports] - E-6003 TOPSEO Correted Original V1.htri - Output Summary

Output Summary Page 1

Released to the following HTRI Member Company:
mekpco
Behrouzi

Xist E Ver. 6.00 8/11/2022 11:52 SN: Vals100+ **MEKPCO Units**

Rating - Horizontal Multipass Flow TEMA BEM Shell With Single-Segmental Baffles

[See Data Check Messages Report for Informative Messages.](#)
[See Runtime Message Report for Informative Messages.](#)

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			PC		CW
Flow rate (kg/hr)			47200.2		166010
Inlet/Outlet Y (Wt. frac vap.)		0.000	0.000	0.000	0.000
Inlet/Outlet T (Deg C)		100.00	65.00	38.00	48.00
Inlet P/Avg (bar-G)		1.500	1.461	4.500	4.217
dP/Allow. (bar)		0.078	0.500	0.565	0.600
Fouling (m2-K/W)			0.000170		0.000300

Exchanger Performance					
Shell h (W/m2-K)		5243.03	Actual U (W/m2-K)		1058.50
Tube h (W/m2-K)		11070.5	Required U (W/m2-K)		1047.70
Hot regime (-)	Sens. Liquid		Duty (MegaWatts)		1.8988
Cold regime (-)	Sens. Liquid		Area (m2)		49.605
EMTD (Deg C)		36.5	Overdesign (%)		1.03

Shell Geometry			Baffle Geometry		
TEMA type (-)		BEM	Baffle type (-)		Single-Seg.
Shell ID (mm)		495.000	Baffle cut (Pct Dia.)		25.00
Series (-)		1	Baffle orientation (-)		Perpend.
Parallel (-)		1	Central spacing (mm)		250.000
Orientation (deg)		0.00	Crosspasses (-)		15

Tube Geometry			Nozzles		
Tube type (-)		Plain	Shell inlet (mm)		97.181
Tube OD (mm)		19.050	Shell outlet (mm)		97.181
Length (m)		4.267	Inlet height (mm)		53.933
Pitch ratio (-)		1.3333	Outlet height (mm)		66.433
Layout (deg)		30	Tube inlet (mm)		146.330
Tube count (-)		196	Tube outlet (mm)		146.330
Tube Pass (-)		2			

Thermal Resistance, %		Velocities, m/s		Flow Fractions	
Shell	20.19	Shellside	0.25	A	0.135
Tube	11.57	Tubeside	2.46	B	0.422
Fouling	56.41	Crossflow	0.31	C	0.305
Metal	11.84	Window	0.44	E	0.138
				F	0.000

Navigation menu:

- Output Summary
- Run Log
- Data Check Message
- Runtime Messages
- Final Results
- Shellside Monitor
- Tubeside Monitor
- Vibration
- Rating Data Sheet
- TEMA Spec Sheet
- Property Monitor
- Stream Properties
- Input Reprint



Xist - [Input] - E-6003 TOPSEO Correted Original V1.htri - Input Summary-Geometry-Tube Layout

Use tube layout drawing as input

Input Summary

- [-] Geometry
 - [+] Shell
 - [+] Reboiler
 - [+] Tubes
 - [+] Tube pass Arrangem
 - [+] Tube Layout
 - [+] Baffles
 - [+] Variable Baffle Spaci
 - [+] Clearances
 - [+] Nozzles
 - [+] Nozzle Location
 - [+] Distributors
 - [+] Impingement
 - [+] Optional
- [+] Piping
- [+] Process
- [+] Hot Fluid Properties
- [+] Cold Fluid Properties
- [+] Design
- [+] Control

TEMA type BEM

Shell diameter 495.000 mm

Outer tube limit 417.794 mm

Height under inlet nozzle 53.933 mm

Height under outlet nozzle 66.433 mm

Tube type Plain

Tube diameter 19.050 mm

Tube pitch 25.400 mm

Tube layout angle 30

Number of tubes (specified) 196

Number of tubes (calculated) 196

Number of tie rods 6

Number of seal strip pairs 0

Number of passes 2

Perpendicular passlane width 15.875 mm

Baffle cut % diameter 25

TUBE PASS DETAILS

Pass	Rows	Tubes	Plugged
1	8	100	0
2	8	102	0

SYMBOL LEGEND

- Tube
- ⊗ Plugged tube
- Tie rod
- ⊙ Impingement rod
- ⊘ Dummy tube
- Seal rod
- Seal strip/Skid bar



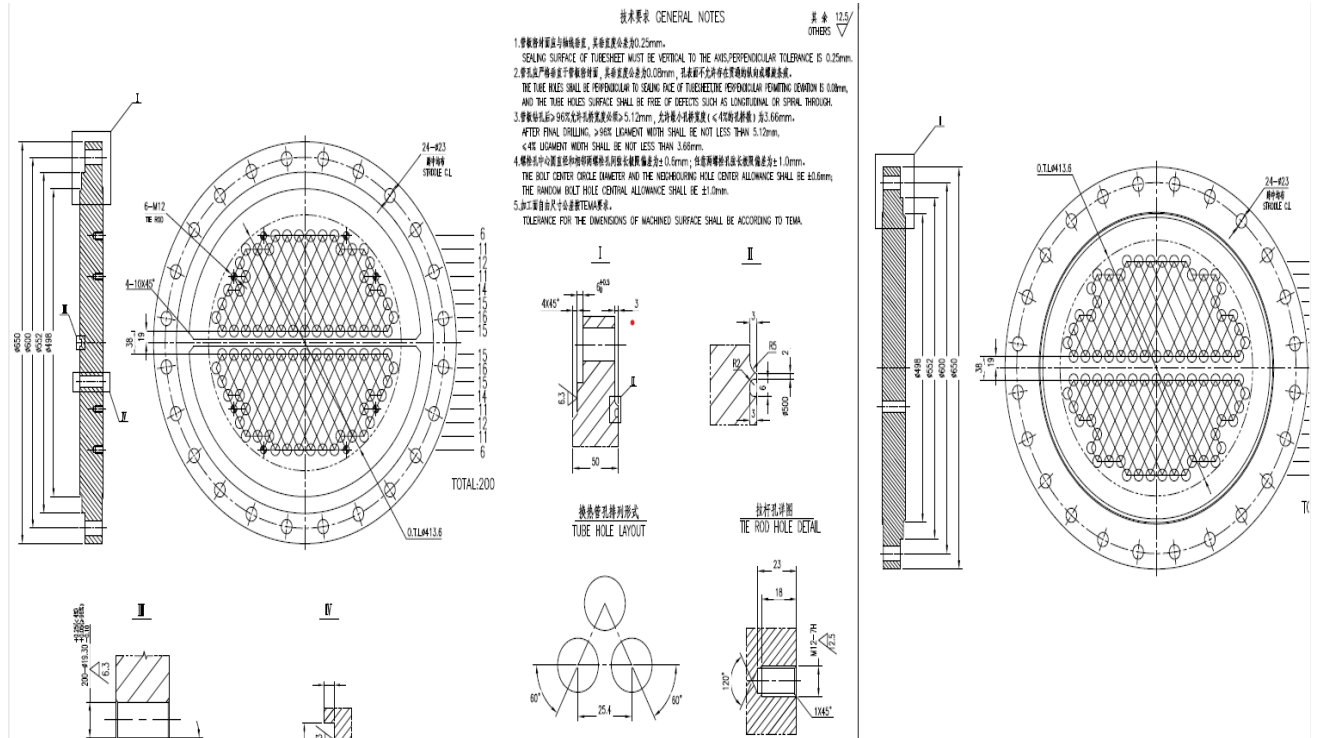
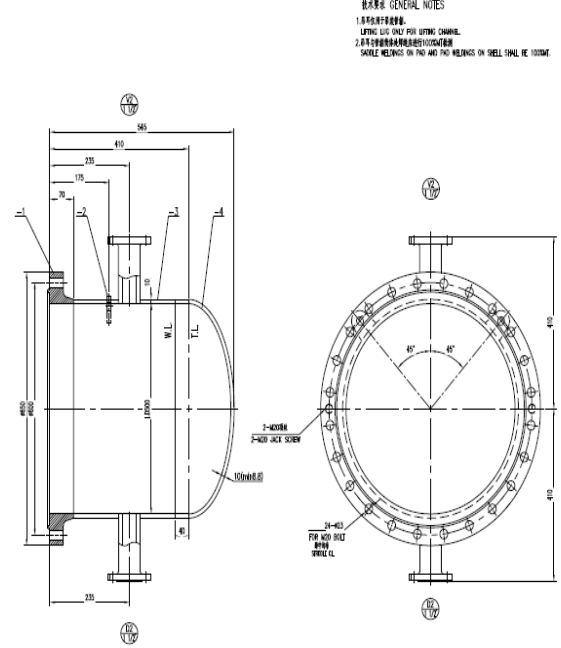
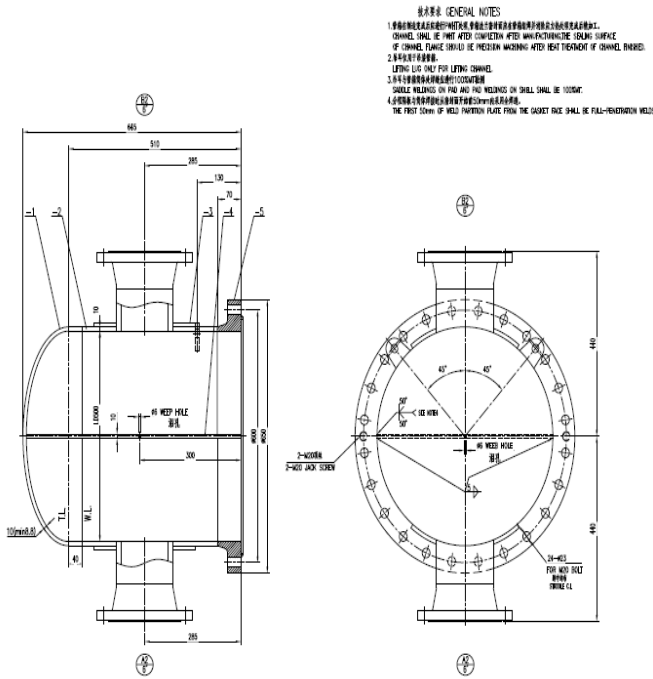
Which one should be selected?

While Topsoe design offers a heat exchanger with lower weight, that of mine offers a heat exchanger with higher oversize factor.

By the way Topsoe configuration was also tested on my design and my configuration was slightly higher than that of Topsoe design



Drawings



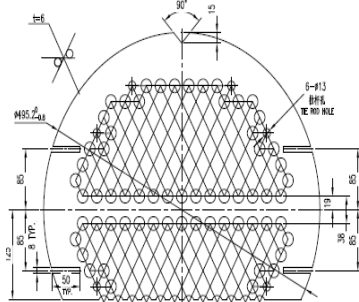


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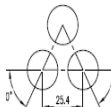
技术要求 GENERAL NOTES

1. 折流板应平整，平面度公差为3mm。
BAFFLE SHALL BE FLAT/ITS PLANE PERMITTING DEVIATION IS 3mm.
2. 相邻两孔中心距允许偏差为±0.3mm，此外相邻两孔中心距最大偏差为±0.5mm，任意两孔中心距最大偏差为±1mm。
THE TOLERANCE OF DISTANCE BETWEEN TWO ADJACENT HOLE CENTER LINE SHALL BE ±0.3mm, AND ALLOWED DEVIATION AND ALLOWED DEVIATION ±0.5mm FOR 4X ADJACENT HOLES, ±1.0mm FOR ANY HOLES.
3. 钻孔后应去除管孔周围的毛刺。
AFTER DRILLING, BURRS AROUND TUBE HOLES SHALL BE REMOVED.
4. 折流板管孔外壁倒角应满足1x45°。
TWO SIDES OF OUTER DIAMETER FOR BAFFLES SHALL BE CHAMFERED WITH 1x45°.

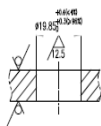
共 套 12.5/
OTHERS



管孔排列形式
TUBE HOLE ARRANGEMENT



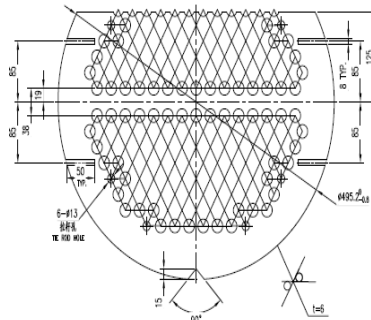
管孔详图
TUBE HOLE DETAIL



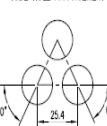
技术要求 GENERAL NOTES

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BAFFLE SHALL BE FLAT/ITS PLANE PERMITTING DEVIATION IS 3mm.
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THE TOLERANCE OF DISTANCE BETWEEN TWO ADJACENT HOLE CENTER LINE SHALL BE ±0.3mm, AND ALLOWED DEVIATION AND ALLOWED DEVIATION ±0.5mm FOR 4X ADJACENT HOLES, ±1.0mm FOR ANY HOLES.
3. 钻孔后应去除管孔周围的毛刺。
AFTER DRILLING, BURRS AROUND TUBE HOLES SHALL BE REMOVED.
4. 折流板管孔外壁倒角应满足1x45°。
TWO SIDES OF OUTER DIAMETER FOR BAFFLES SHALL BE CHAMFERED WITH 1x45°.

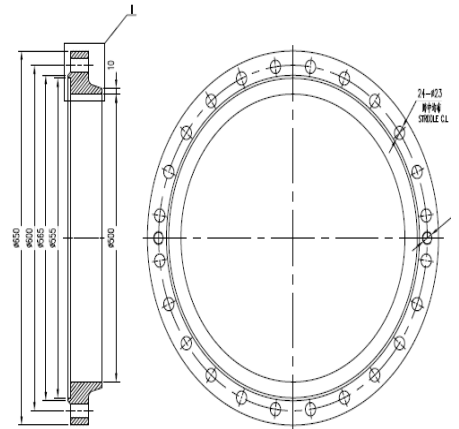
共 套 12.5/
OTHERS



管孔排列形式
TUBE HOLE ARRANGEMENT

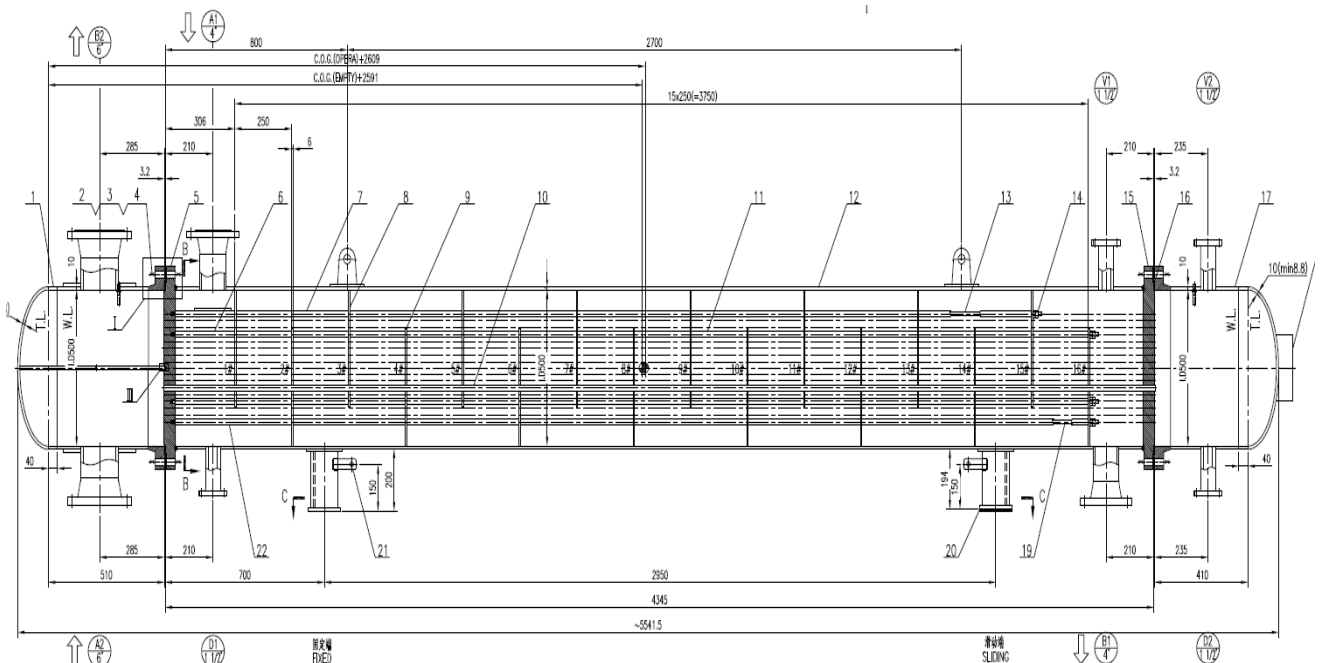
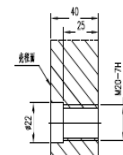
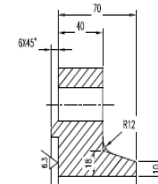


管孔详图
TUBE HOLE DETAIL

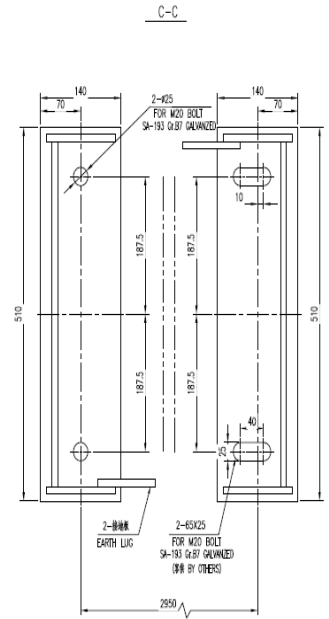
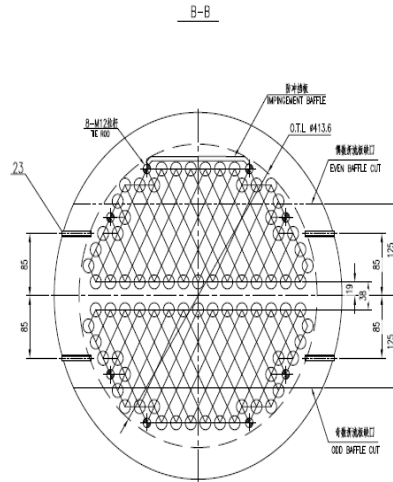
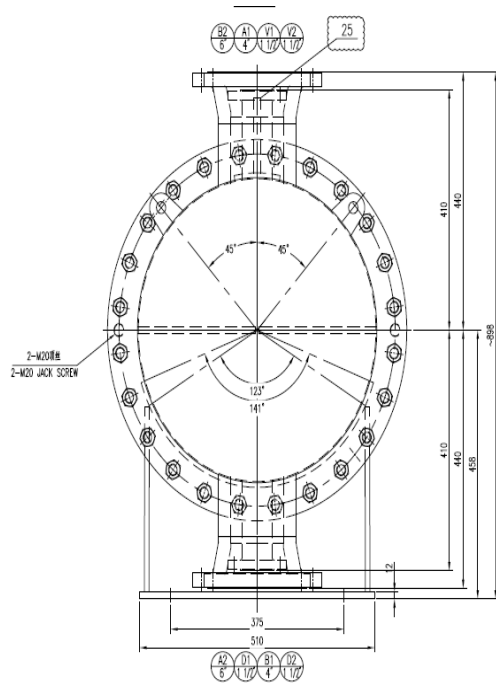


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管孔详图
DETAIL FOR JACK BOLT HOLE



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Datasheet

Heat Exchanger Main Data					
TEMA type	BEM		Calculated surface area per unit	45,2	m ²
Duty	1,9	MW	Installed surface area per unit	49,9	m ²
MTD	38	°C	Shells per unit	1	
Corrected MTD	36,3	°C			
Operating Data (One Unit)					
Description	Shell Side		Tube Side		Units
	Inlet	Outlet	Inlet	Outlet	
Fluids	Process condensate		Cooling water		
Quantity: total	47200		166009		kg/h
liquid	47200	47200	166009	166009	kg/h
gas					kg/h
Operating temperature	100	65	38	48	°C
Operating pressure	1,5		4,5		bar g
Liquid: molecular weight	18,02	18,02	18,02	18,02	kg/kmol
density	958	980	993	989	kg/m ³
viscosity	0,283	0,434	0,681	0,567	cP
specific heat capacity	4,213	4,184	4,175	4,177	kJ/kg/°C
thermal conductivity	0,6768	0,6505	0,6199	0,6323	W/m/°C
boiling temperature	106				°C
Gas: molecular weight					kg/kmol
density					kg/m ³
viscosity					cP
specific heat capacity					kJ/kg/°C
thermal conductivity					W/m/°C
dew point					°C
Performance					
Pressure drop, max. allowable/calculated	/ 0,1		/ 0,6		bar
Fouling resistance	0,00017		0,00030		m ² ·°C/W
Film coefficient, refers to outside surface	5715,95		10667,4		W/m ² /°C
Heat transfer coefficients (clean/dirty)	2631,24		1171,95		W/m ² /°C
Mean metal temperature	80		57		°C
Mechanical Design					
Mechanical Design Conditions					
Design temperature (min/max)	/ 125		/ 100		°C
Design pressure (min/max)	1)	/ 9,0	/ 7,5		bar g
Test pressure					bar g
Number of passes	1		2		
General					
Construction code	ASME Sec. VIII Div. 1 or 2		Stress relieving	According to code	
TEMA Class	TEMA Class R		Design mean metal temp. diff.	30	°C
Shell					
Shell inner diameter (ID)	455	mm	Shell orientation	Horizontal	
Construction material	SS		Corrosion allowance	0	mm
Insulation purpose	Personnel protection				
Impingement plate (shell inlets)	Yes				
Front and Rear End Heads					
Front end head material	CS		Corrosion allowance	3	mm
Front end head insulation	None				
Rear end head material	CS		Corrosion allowance	3	mm
Rear end head insulation	None				



Tube Bundle					
No. of tubes	196		Effective tube length	4250	mm
Construction material	Duplex SS		Total tube length incl. tubesheet		mm
Tube outer diameter (OD)	19,05	mm	Tube inner diameter (ID)	15,75	mm
Tube pitch pattern	Triangular		Tube pitch	25,4	mm
Minimum distance from shell side inlet nozzle to tube bundle: 55 mm					
Tubesheets					
Construction material	SS		Corrosion allowance	0	mm
Baffles, Tie Rods and Dummy Tubes					
Baffle type	Single segmental		Baffle cut type	Horizontal	
Baffle spacing	250	mm	Construction material	SS	
Baffle cut (% of shell ID)	25	%	Free baffle hole area	0,0234	m ²
Tubes in outer baffle window	Yes				