Runtime Messages

Released to the following HTRI Member Company:
WCE
RLZ

Xist 8.2 2022/7/25 19:09 SN: 01096-111007767 **US_AP Units**

Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

An excessive latent heat >2556 kj/kg (1100 BTU/lb) has been calculated for the hot fluid at isobar no. 3 around increment no. 8. Using specific heats, the program calculates the incremental sensible vapor duty and the sensible liquid duty, and subtracts them from the total incremental duty. The latent heat has been limited to 2556 kj/kg (1100 Btu/lb). Check the specified heat release curve, liquid and vapor specific heat, and enthalpy values; rerun the case.

The design has parallel-cut baffles and the reported height under the nozzle lowers the bundle below the baffle cut. Unrestricted longitudinal flow can bypass the bundle. This bypass region can be reduced by decreasing the height under the nozzle, changing the baffle cut, or adding sealing arrangements.

The inlet baffle spacing is less than the calculated minimum inlet spacing 23.125 in. (587 mm) using estimated nozzle clearance requirements. This could result in the first baffle being placed beneath or before the inlet nozzle. This geometry is not recommended.

The longest unsupported span of the bundle is in the U-bend region and thus prone to excessive vibration, even with a full support plate. The longest unsupported span should be in the straight portion of the U-tube.

ASME Section VIII Div. 1 Code was used to ESTIMATE all pressure vessel dimensions and weights. The dimensions in this report cannot be used to fabricate the vessel.

Specified inlet shell nozzle thickness does not meet UG-45 requirements - reinforcement calculations aborted.

Specified outlet shell nozzle thickness does not meet UG-45 requirements - reinforcement calculations aborted.

HEAT EXCHANGER SPECIFICATION SHEET

Released to the following HTRI Member Company:
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US_AP Units

Customer			Job No.	
Address			Reference No.	
Plant Location			Proposal No.	
Service of Unit	Vapor Cooler		Date	2022/7/25 Rev 02
Size	22.624 x 180 inch	Type AEU Horizontal	Item No.	18-X-356
Surf/Unit (Gross/Eff)	818.78 / 791.21 ft2	Shell/Unit 1	Connected In	1 Parallel 1 Series
			Surf/Shell (Gross/Eff)	818.78 / 791.21 ft2

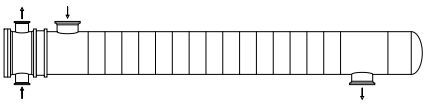
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Isomerization Reactor Effluent		Cooling Water	
Fluid Quantity, Total	lb/hr	101022		137670	
Vapor (In/Out)		20115	17272		
Liquid		80907	83750	137670	137670
Steam					
Water					
Noncondensables					
Temperature (In/Out)	F	130.00	105.00	80.00	96.00
Specific Gravity		0.6705	0.6796	0.9972	0.9945
Viscosity	cP	0.0101 V/L 0.4378	0.0095 V/L 0.4878	0.8572	0.7113
Molecular Weight					
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.4669 V/L 0.5393	1.6256 V/L 0.5197	0.9990	0.9986
Thermal Conductivity	Btu/hr-ft-F	0.0936 V/L 0.1484	0.0932 V/L 0.2589	0.3521	0.3598
Latent Heat	Btu/lb	132.96	139.36		
Inlet Pressure	psig	427.00		60.000	
Velocity	ft/sec	34.80		5.08	
Pressure Drop, Allow/Calc	psi	10.000	9.834	10.000	7.173
Fouling Resistance (min)	ft2-hr-F/Btu	0.00200		0.00200	

Heat Exchanged 2.2148 MM Btu/hr MTD (Corrected) 26.7 F
Transfer Rate, Service 104.09 Btu/ft2-hr-F Clean 299.03 Btu/ft2-hr-F Actual 125.19 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	550.00 /	425.00 /
Design Temperature		F	490.00	150.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 9.7500	1 @ 5.5010
	Out	inch	1 @ 9.7500	1 @ 5.5010
	Intermediate		@	@

Tube No. 139U OD 0.7500 inch Thk(Avg) 0.0913 inch Length 180.00 in Pitch 1.0000 inch
Tube Type Plain Material SA-179 Tube (S) K01200 Tube pattern 90
Shell SA-516 70 Pl. K02700 ID 22.624 OD 24.356 inch | Shell Cover SA-516 70 Pl. K02700 (Integ.)
Channel or Bonnet SA-516 70 Pl. K02700 | Channel Cover SA-516 70 Pl. K02700
Tubesheet-Stationary SA-266 Gr.2 | Tubesheet-Floating
Floating Head Cover | Impingement Plate Rods
Baffles-Cross Carbon steel Type Single-Seg. %Cut (Diam) 25.14 Spacing(c/c) 8.6140 Inlet 22.441 inch
Baffles-Long Seal Type None
Supports-Tube U-Bend Type Full support
Bypass Seal Arrangement 2 pairs seal strips Tube-Tubesheet Joint Strength welded
Expansion Joint Type None
Rho-V2-Inlet Nozzle 1591.0 lb/ft-sec2 Bundle Entrance 868.60 Bundle Exit 855.12 lb/ft-sec2
Gaskets-Shell Side Mach. Mtl. (Kammprofile\Flex. Face) Tube Side Mach. Mtl. (Kammprofile\Flex. Face)
- Floating Head
Code Requirements ASME TEMA Class R
Weight/Shell 9649.3 lb Filled with Water 12564 lb Bundle 4152.8 lb

Remarks:

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Final Results

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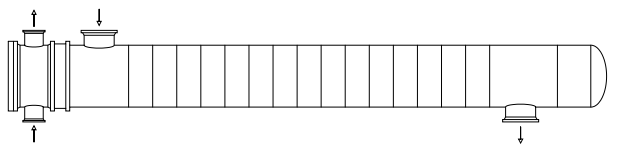
Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Process Data		Hot Shellside		Cold Tubeside	
Fluid name		Isomerization Reactor Effluent		Cooling Water	
Fluid condition		Cond. Vapor		Sens. Liquid	
Total flow rate	(lb/hr)	101022		137670	
Weight fraction vapor, In/Out	(--)	0.1991	0.1710	0.0000	0.0000
Temperature, In/Out	(Deg F)	130.00	105.00	80.00	96.00
Skin temperature, Min/Max	(Deg F)	99.16	118.56	85.61	99.65
Wall temperature, Min/Max	(Deg F)	94.18	110.79	93.45	109.65
Pressure, In/Average	(psig)	427.00	422.08	60.000	56.413
Pressure drop, Total/Allowed	(psi)	9.834	10.000	7.173	10.000
Velocity, Mid/Max allow	(ft/sec)	34.80		5.08	
Mole fraction inert	(--)		0.0000		
Average film coef.	(Btu/ft2-hr-F)		500.59		1255.5
Heat transfer safety factor	(--)		1.0000		1.0000
Fouling resistance	(ft2-hr-F/Btu)		0.00200		0.00200

Overall Performance Data

Overall coef., Reqd/Clean/Actual	(Btu/ft2-hr-F)	104.09 /	299.03 /	125.19
Heat duty, Calculated/Specified	(MM Btu/hr)	2.2148 /	2.2000	
Effective overall temperature difference	(Deg F)	26.7		
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	26.9 *	0.9939 *	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside (ft3)	34.103
Approximate tubeside (ft3)	12.601

Shell Construction Information

TEMA shell type	AEU		Shell ID	(inch)	22.624
Shells Series	1 Parallel	1	Total area	(ft2)	818.78
Passes Shell	1 Tube	4	Eff. area	(ft2/shell)	791.21
Shell orientation angle (deg)	0.00				
Impingement present	Rods		Impingement rod rows		2
Pairs seal strips	2		Passlane seal rods (inch)	0.3540	No. 3
Shell expansion joint	No		UBend tangent to Support Dist. (inch)		2.0000
Weight estimation Wet/Dry/Bundle		12564 /	9649.3 /	4152.8	(lb/shell)

Baffle Information

Type	Parallel	Single-Seg.	Baffle cut (% dia)		25.14
Crosspasses/shellpass		17	No.	(Pct Area)	(inch) to C.L
Central spacing	(inch)	8.6140	1	19.54	5.6250
Inlet spacing	(inch)	22.441	2	0.00	0.0000
Outlet spacing	(inch)	22.289			
Baffle thickness	(inch)	0.3940			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		278
Length to tangent	(in)	180.00	Pct tubes removed (both)		15.83
Effective length	(in)	173.94	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	4.0600	Wall thickness	(inch)	0.0913
Area ratio	(out/in)	1.3218	Pitch (inch) 1.0000	Ratio	1.3333
Tube metal	SA-179 Tube (S) K01200		Tube pattern (deg)		90

Shellside Performance

Nom vel, X-flow/window 42.58 / 39.47

Flow fractions for vapor phase
A=0.1537 B=0.5067 C=0.0649 E=0.1380 F=0.1366

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
0.983	0.920	1.069	0.912	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
80.04	10.12	4.34	Inlet	3.63	1.43
MOMENTUM		-0.67	Outlet	2.54	0.91

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
RPM	Shear	Shear	Inter	0.4546

H. T. Parameters		Shell	Tube
Overall wall correction			1.004
Midpoint	Prandtl no.		5.25
Midpoint	Reynolds no.	12631	28707
Bundle inlet	Reynolds no.	7632	26023
Bundle outlet	Reynolds no.	6737	30661
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
25.01	13.18	58.13	3.68	20.27

Total fouling resistance (ft2-hr-F/Btu) 0.0046
Differential resistance (ft2-hr-F/Btu) 0.0016

Shell Nozzles		Inlet	Outlet	Liquid Outlet
Inlet at channel end-Yes				
Number at each position		1	1	0
Diameter	(inch)	9.7500	9.7500	
Velocity	(ft/sec)	29.40	28.55	
Pressure drop	(psi)	0.357	0.250	
Height under nozzle	(inch)	1.5740	3.1930	
Nozzle R-V-SQ	(lb/ft-sec2)	1591.0	1545.4	
Shell ent.	(lb/ft-sec2)	2138.8	869.18	

Tube Nozzle		Inlet RADIAL	Outlet RADIAL	Liquid Outlet
Diameter	(inch)	5.5010	5.5010	
Velocity	(ft/sec)	3.72	3.73	
Pressure drop	(psi)	0.102	0.065	
Nozzle R-V-SQ	(lb/ft-sec2)	862.71	865.13	

Annular Distributor		Inlet	Outlet
Length	(inch)		
Height	(inch)		
Slot area	(in2)		

Diametral Clearances (inch)

Baffle-to-shell	Bundle-to-shell	Tube-to-baffle
0.1875	0.7556	0.0313

Supplementary Results

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Externally Enhanced Tube Geometry			**Internally Enhanced Tube Geometry**		
Type		Plain	Type		None
Fin density	(fin/inch)		Thickness	(inch)	
Fin height	(inch)		Pitch	(L/D)	
Fin thickness	(inch)				
Root diameter	(inch)				
Area/length	(ft2/ft)				

Mean Metal Temperatures

Mean shell temperature	115.79 (F)
Tubesheet temperature	490.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	97.66	98.84	98.31
2	99.96	101.01	100.53
3	102.69	103.61	103.19
4	104.14	104.94	104.57

Vibration Analysis

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1	Shellside condition		Cond. Vapor	(Level 2.3000)	
2	Axial stress loading	(1000-psi)	0.000	Added mass factor	1.394
3	Beta		2.717		

	Position In The Bundle		Inlet	Center	Outlet
5	Length for natural frequency	(in)	31.055	17.228	30.903
6	Length/TEMA maximum span	(--)	0.518	0.287	0.515
7	Number of spans	(--)	9	9	9
8	Tube natural frequency	(Hz)	127.3 +	237.2	128.4
9	Shell acoustic frequency	(Hz)			
10	**Flow Velocities**		**Inlet**	**Center**	**Outlet**
11	Window parallel velocity	(ft/sec)	34.05	33.38	33.08
12	Bundle crossflow velocity	(ft/sec)	13.44	35.97	13.14
13	Bundle/shell velocity	(ft/sec)	22.95	22.49	8.22
14	**Fluidelastic Instability Check**		**Inlet**	**Center**	**Outlet**
15	Log decrement	HTRI	0.043	0.053	0.044
16	Critical velocity	(ft/sec)	45.92	164.71	46.51
17	Baffle tip cross velocity ratio	(--)	0.2637	0.1968	0.2546
18	Average crossflow velocity ratio	(--)	0.2927	0.2184	0.2826
19	**Acoustic Vibration Check**		**Inlet**	**Center**	**Outlet**
20	Vortex shedding ratio	(--)			
21	Chen number	(--)			
22	Turbulent buffeting ratio	(--)			
23	**Tube Vibration Check**		**Inlet**	**Center**	**Outlet**
24	Vortex shedding ratio	(--)	0.598	1.600	0.585
25	Parallel flow amplitude	(inch)	0.0002	0.0001	0.0002
26	Crossflow amplitude	(inch)	0.0017	0.0020	0.0016
27	Tube gap	(inch)	0.2500	0.2500	0.2500
28	Crossflow amplitude/tube gap	(--)	0.0066	0.0080	0.0063
29	Crossflow RHO-V-SQ	(lb/ft-sec2)	332.60	2430.1	327.48

	Bundle Entrance/Exit			
31	**(analysis at first tube row)**		**Entrance**	**Exit**
32	Fluidelastic instability ratio	(--)	0.473	0.457
33	Vortex shedding ratio	(--)	0.966	0.945
34	Crossflow amplitude	(inch)	0.02048	0.01910
35	Crossflow velocity	(ft/sec)	21.72	21.24
36	Tubesheet to inlet/outlet support	(inch)	None	None
37	**Shell Entrance/Exit Parameters**		**Entrance**	**Exit**
38	Impingement device		Rods	--
39	Flow area	(ft2)	0.447	0.691
40	Velocity	(ft/sec)	34.08	21.41
41	Critical velocity	(ft/sec)	45.92	46.51
42	RHO-V-SQ	(lb/ft-sec2)	2138.8	869.18

43	Shell type	AEU	Baffle type	Single-Seg.
44	Tube type	Plain	Baffle layout	Parallel
45	Pitch ratio	1.3333	Tube diameter, (inch)	0.7500
46	Layout angle	90	Tube material	SA-179 Tube (S) K01200
47	Number U-Bend supports		Elastic modulus, (1000-psi)	29177
48	Use deresonating baffles	No	Supports/baffle space	

Program Messages

+ Natural or acoustic frequency used in vibration analysis.
See help for additional information.
* Items with asterisk exceed a conservative lower limit for vibration-free design.
Review your case using the procedure described in Online Help;
You may find that a vibration problem is unlikely.

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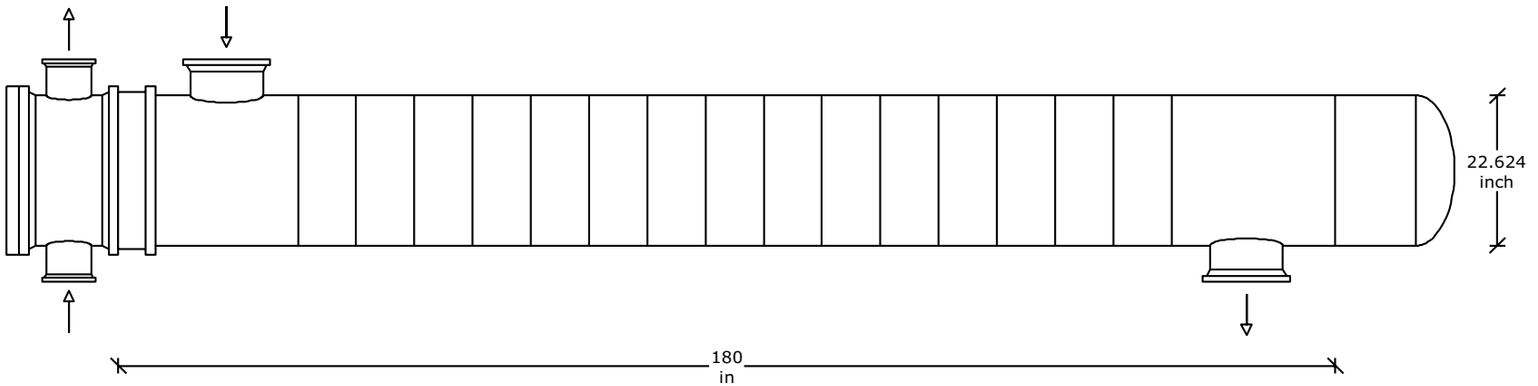

Unit	Shell 1		Total tube inlet nozzles	1	Stream ID		Shellside		Tubeside	
Item number	18-X-356		Total tube outlet nozzles	1	Stream name		Isomerization Reactor Effluent		Cooling Water	
TEMA type	AEU		Total shell inlet nozzles	1	Flow, lb/hr		101022		137670	
Shell diameter	22.624	inch	Total shell outlet nozzles	1	Pressure drop, psi		9.834		7.173	
Tube length	180	in			Temperature, F	130.00	105.00	80.00	96.00	
Dry weight	9649	lb/shell			Wt. fraction vapor	0.1991	0.1710	0.0000	0.0000	
Wet weight	12564	lb/shell			Pressure, psig	427.00	417.17	60.000	52.827	
Bundle weight	4153	lb/shell								

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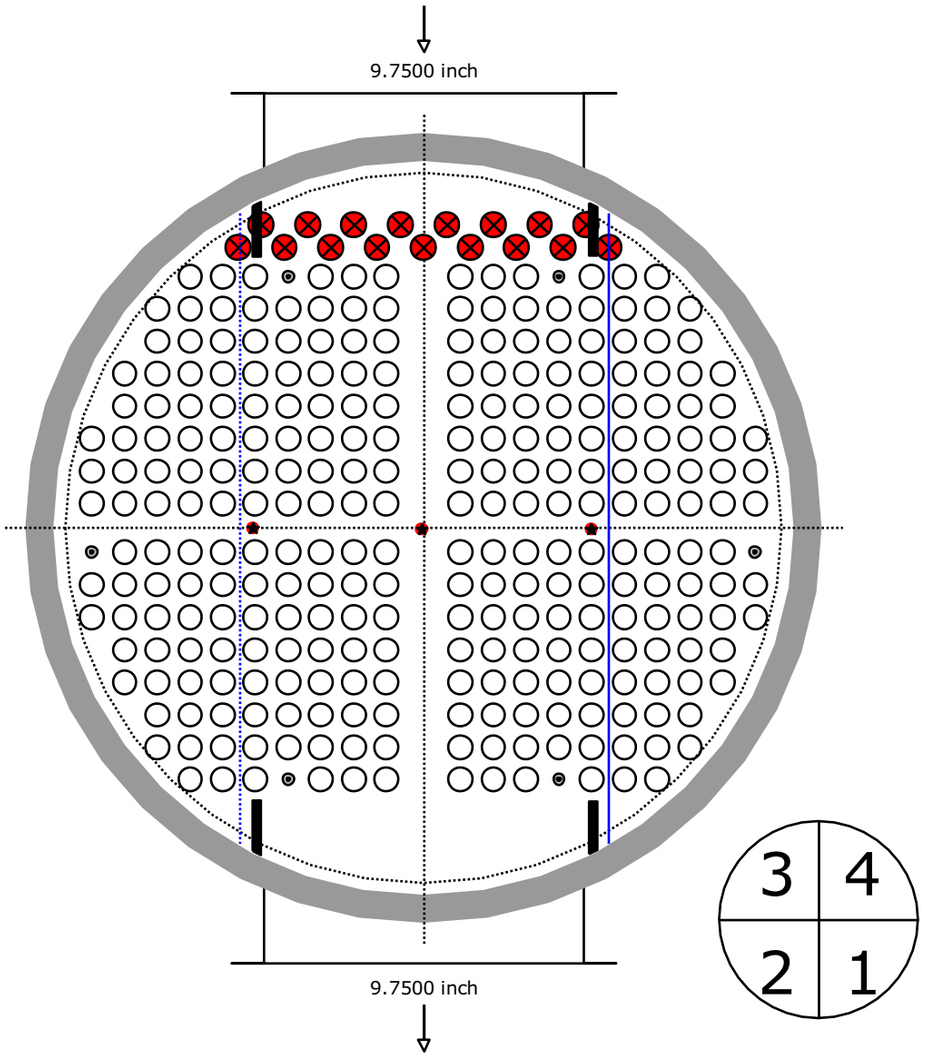

Unit	Shell 1
Item number	18-X-356
TEMA type	AEU
Shell ID	22.624 inch
Actual OTL	21.868 inch
Height under inlet nozzle	1.5740 inch
Rows of impingement rods	2
Impingement rod OD	0.7870 inch
Height under outlet nozzle	3.1930 inch
Tube type	Plain
Tube OD	0.7500 inch
Tube pitch	1.0000 inch
Tube layout angle	90 deg
Tubes	278
Tube positions available	278
Tie rods	6
Seal strip pairs	2
Passlane seal rods	3
Tube Passes	4
Parallel passlane width	0.7380 inch
Perpendicular passlane width	1.5000 inch
Baffle cut % diameter	25.14

TUBEPASS DETAILS

Pass	Rows	Tubes
1	8	69
2	8	69
3	8	70
4	8	70

SYMBOL LEGEND
- Tube
- Dummy Short Tube
- Dummy Long Tube
- Plugged Tube
- Tie Rod
- Seal Rod
- Impingement Rod

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1	**Exchanger Data**		
2	Unit identifier	Shell 1	
3	Service type	Generic shell and tube	
4	TEMA type	AEU	
5	Run mode	Rating	
6	Hot fluid location	Shellside	
7	Unit orientation	Horizontal	
8	Number of shells in series	1	
9	Number of shells in parallel	1	
10	Flow in 1st tubepass	Cocurrent	
11	Train flow direction	Countercurrent	
12			
13	**Construction Data**		
14	Shell material	SA-516 70 Pl. K02700	
15	Tube material	SA-179 Tube (S) K01200	
16	Shell cover material	SA-516 70 Pl. K02700	
17	Channel or bonnet material	SA-516 70 Pl. K02700	
18	Channel cover material	SA-516 70 Pl. K02700	
19	Tubesheet-Stationary material	SA-266 Gr.2	
20	Baffle-Cross material	Carbon steel	
21	Shellside gasket	Mach. Mtl. (Kammprofile\Flex. Face)	
22	Tubeside gasket	Mach. Mtl. (Kammprofile\Flex. Face)	
23	Shellside design pressure	550.00	psig
24	Tubeside design pressure	425.00	psig
25	Shellside vacuum pressure	FV @300	
26	Tubeside vacuum pressure	FV @300	
27	Shellside design temperature	490.00	F
28	Tubeside design temperature	150.00	F
29	Shellside corrosion allowance	0.1250	inch
30	Tubeside corrosion allowance	0.1250	inch
31	Tubesheet design temperature	490.00	F
32	Shellside radiography	None	
33	Tubeside radiography	None	
34	TEMA class	R	
35	Small exchanger	No	
36	Shell outside diameter	24.356	inch
37	Shell inside diameter	22.624	inch
38	Shell wall thickness	0.8660	inch
39	Front head outside diameter	24.042	inch
40	Front head inside diameter	22.624	inch
41	Front head thickness	0.7090	inch
42	Rear head outside diameter	23.874	inch
43	Rear head inside diameter	22.624	inch
44	Rear head thickness	0.5510	inch
45	Total tubesheet thickness	4.0600	inch
46	Double tubesheet	No	
47	Shell expansion joint	No	
48	Suppress mechanical calculations	No	
49			
50			

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1	**Tube Data**				
2	Tube type			Plain	
3	Tube outside diameter			0.7500	inch
4	Tube wall thickness			0.0913	inch
5	Tube pitch			1.0000	inch
6	Tube pitch ratio			1.3333	
7	Tubepasses per shell			4	
8	Tube pattern			90	degrees
9	Tube count method			Rigorous	
10	Tube length			180.00	in
11	Tube material			SA-179 Tube (S) K01200	
12					
13	**Baffle Data**				
14	Baffle type			Single segmental	
15	Baffle orientation			Parallel	
16	Baffle cut percent			25.140	% shell ID
17	Adjust baffle cut			Between rows	
18	Number of crosspasses			17	
19	Central baffle spacing			8.6140	inch
20	Inlet baffle spacing			22.441	inch
21	Variable baffle spacing			No	
22	Baffle thickness			0.3940	inch
23	Window cut from baffles			No	
24	Use deresonating baffles			No	
25					
26	**Supports Data**				
27	Full support at U-Bend			Full support	
28	Support distance to U-bend tangent			2.0000	inch
29	Include inlet vibration support			No	
30	Include outlet vibration support			No	
31					
32	**Nozzle Data**				
33	**Shellside**				
34	Nozzle standard			01-ANSI_B36_10.TABLE	
35	Shell entrance type			Use impingement device	
36	Shell exit type			Remove tubes if TEMA requires	
37		**Inlet**	**Outlet**	**Liq. Outlet**	
38	Nozzle outside diameter	10.750	10.750	--	inch
39	Nozzle schedule	Sch 60	Sch 60	--	
40	Nozzle inside diameter	9.7500	9.7500	--	inch
41	Number at this position	1	1	--	
42	**Tubeside**				
43	Nozzle standard			01-ANSI_B36_10.TABLE	
44		**Inlet**	**Outlet**	**Liq. Outlet**	
45	Nozzle outside diameter	6.6250	6.6250	--	inch
46	Nozzle schedule	Sch 120	Sch 120	--	
47	Nozzle inside diameter	5.5010	5.5010	--	inch
48	Number at this position	1	1	--	
49					
50					

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Nozzle Location Data

Radial position on shell inlet nozzle	Program decides	
Longitudinal position on shell of inlet nozzle	At front head	
Radial position on shell outlet nozzle	Program decides	
Location of nozzle at U-bend	Before U-bend	
Tubeside entry type	Radial	
Tubeside inlet position	Front head	
Tubeside exit type	Same as inlet	

Impingement Data

Impingement type	Rods	
Use tube positions to place rods	No	
Impingement rod rows	2	
Impingement rod diameter	0.7870	inch
Impingement rod pitch	1.0000	inch
Impingement rods on centerline	Program set	
Impingement rod layout angle	45.00	deg
Rod row width to nozzle diameter	1.0000	

Tube Layout Data

Tubepass layout	Quadrant	
First tubepass location	Bottom right	
Pass partition construction	Program set	
Force symmetric layout	No	
Force continuous cleaning lanes	No	
Force uniform layout	No	
Align across primary passlanes	No	
Fill knock out area with dummy tubes	Program set	
Fill bundle periphery with dummy tubes	Program set	
Fill passlanes with dummy tubes	Program Set	
Square layout tube alignment	Program set	
Use crossed U-bends	No	
Minimum U-bend diameter	2.2500	inch
Use tube layout drawing as input	Yes	

	Inlet	Outlet	Liq. Outlet	
Height under nozzle	2.0000	--	--	inch
Tube rows removed under nozzle	2	2	0	

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Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Clearance Data		
Number of seal strip pairs	2	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	0.7380	inch
Perpendicular/horizontal passlane width	1.5000	inch
Number of passlane seal rods	3	
Passlane seal rod diameter	0.3540	inch
Tubes to remove for tie rods	None	
Number of tie rods	6	
Tie rod outside diameter	0.3750	inch
Baffle to shell clearance	0.1875	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Two phase	Sensible liquid	
Flow rate	101022	137670	lb/hr
Inlet vapor fraction	--	0.0000	
Outlet vapor fraction	--	0.0000	
Inlet temperature	130.00	80.00	F
Outlet temperature	105.00	96.00	F
Inlet pressure	427.00	60.000	psig
Allowable pressure drop	10.000	10.000	psi
Exchanger duty		2.2000	MM Btu/hr
Duty multiplier		1.0000	

Process Fouling Data	**Hot Fluid**	**Cold Fluid**	
Fouling resistance	0.0020	0.0020	ft2-hr-F/Btu

Hot Fluid Property Data	
Fluid name	Isomerization Reactor Effluent
Physical property method	Property tables
Temperature interpolation option	Program
Flash type	Integral
Quantity units	Moles
Heat release type	Specific enthalpy

Hot Fluid Physical Property Data

Pressure Set, 385.30 psig

Temp. F	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Vapor Enthalpy Btu/lb	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
90.00	0.1592	0.3000	0.0092	0.0924	1.7071	-523.2	42.790	0.5275
101.00	0.1711	0.3146	0.0094	0.0926	1.6217	-533.1	42.550	0.5014
112.00	0.1839	0.3300	0.0097	0.0927	1.5431	-542.3	42.310	0.4779
123.00	0.1975	0.3460	0.0100	0.0928	1.4711	-550.8	42.070	0.4568
134.00	0.2120	0.3625	0.0102	0.0929	1.4054	-558.3	41.840	0.4377
145.00	0.2273	0.3796	0.0106	0.0928	1.3456	-564.9	41.620	0.4203

Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Hot Fluid Physical Property Data

Pressure Set, 385.30 psig

Temp. F	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Vapor Enthalpy Btu/lb	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
156.00	0.2435	0.3970	0.0109	0.0928	1.2916	-570.6	41.400	0.4046
167.00	0.2603	0.4147	0.0112	0.0926	1.2428	-575.2	41.180	0.3902
178.00	0.2779	0.4325	0.0115	0.0925	1.1988	-578.9	40.970	0.3771
189.00	0.2961	0.4504	0.0119	0.0924	1.1594	-581.6	40.760	0.3650
200.00	0.3149	0.4682	0.0123	0.0922	1.1242	-583.4	40.560	0.3537

Pressure Set, 385.30 psig

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Enthalpy Btu/lb	Liquid Surface Tension dyne/cm
90.00	0.0615	0.5103	-954.6	17.425
101.00	0.6094	0.5170	-947.4	16.993
112.00	0.6039	0.5236	-940.1	16.577
123.00	0.5986	0.5302	-932.6	16.174
134.00	0.5936	0.5680	-925.1	15.785
145.00	0.5888	0.5433	-917.4	15.411
156.00	0.5841	0.5497	-909.7	15.050
167.00	0.5797	0.5561	-901.9	14.703
178.00	0.5755	0.5624	-894.0	14.369
189.00	0.5714	0.5686	-886.1	14.048
200.00	0.5675	0.5748	-878.2	13.740

Pressure Set, 435.30 psig

Temp. F	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Vapor Enthalpy Btu/lb	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
90.00	0.1527	0.3246	0.0091	0.0931	1.7625	-506.2	42.720	0.5199
101.00	0.1640	0.3400	0.0094	0.0934	1.6748	-516.4	42.470	0.4937
112.00	0.1761	0.3564	0.0096	0.0936	1.5935	-526.2	42.220	0.4701
123.00	0.1890	0.3734	0.0099	0.0938	1.5188	-535.2	41.980	0.4488
134.00	0.2027	0.3912	0.0102	0.0938	1.4503	-543.4	41.740	0.4296
145.00	0.2173	0.4095	0.0105	0.0938	1.3878	-550.8	41.510	0.4121
156.00	0.2327	0.4283	0.0108	0.0938	1.3309	-557.2	41.280	0.3963
167.00	0.2489	0.4475	0.0111	0.0937	1.2795	-562.6	41.060	0.3818
178.00	0.2657	0.4670	0.0144	0.0936	1.2330	-567.0	40.840	0.3685
189.00	0.2833	0.4867	0.0179	0.0935	1.1911	-570.5	40.620	0.3564
200.00	0.3015	0.5063	0.0121	0.0933	1.1535	-573.1	40.410	0.3450

Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Hot Fluid Physical Property Data

Pressure Set, 435.30 psig

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Enthalpy Btu/lb	Liquid Surface Tension dyne/cm
90.00	0.0614	0.5107	-955.3	17.283
101.00	0.0608	0.5174	-948.2	16.842
112.00	0.0602	0.5241	-940.9	16.416
123.00	0.0597	0.5307	-933.5	16.005
134.00	0.0591	0.5373	-926.0	15.607
145.00	0.0586	0.5438	-918.4	15.223
156.00	0.0582	0.5503	-910.7	14.853
167.00	0.0577	0.5567	-903.0	14.496
178.00	0.0572	0.5631	-895.1	14.153
189.00	0.0568	0.5693	-887.2	13.823
200.00	0.0564	0.5756	-879.3	13.507

Pressure Set, 485.30 psig

Temp. F	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Vapor Enthalpy Btu/lb	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
90.00	0.1473	0.3484	0.0091	0.0938	1.8131	-490.7	42.660	0.5133
101.00	0.1579	0.6460	0.0093	0.0942	1.7234	501.10	42.400	0.4870
112.00	0.1694	0.3818	0.0096	0.0944	1.6400	-511.2	42.150	0.4633
123.00	0.1817	0.3999	0.0098	0.0946	1.5629	-520.7	41.900	0.4420
134.00	0.1948	0.4187	0.0101	0.0947	1.4920	-529.4	41.660	0.4227
145.00	0.2087	0.4382	0.0104	0.0947	1.4271	-537.4	41.420	0.4051
156.00	0.2235	0.4584	0.0107	0.0947	1.3678	-544.4	41.180	0.3892
167.00	0.2390	0.4790	0.0102	0.0946	1.3139	-550.6	40.950	0.3746
178.00	0.2552	0.5000	0.0114	0.0945	1.2651	-555.7	40.730	0.3612
189.00	1.0000	1.7500	0.0180	0.0666	0.7020	-716.1	--	--
200.00	0.2898	0.5426	0.0120	0.0943	1.1813	-563.2	40.290	0.3375

Pressure Set, 485.30 psig

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Enthalpy Btu/lb	Liquid Surface Tension dyne/cm
90.00	0.0612	0.5110	-955.9	17.156
101.00	0.0606	0.5178	-948.8	16.708
112.00	0.0600	0.5245	-941.6	16.274
123.00	0.0595	0.5311	-934.3	15.854
134.00	0.0589	0.5377	-926.8	15.448
145.00	0.0584	0.5443	-919.3	15.056
156.00	0.0579	0.5508	-911.6	14.677
167.00	0.0574	0.5573	-903.9	14.312
178.00	0.0570	0.5637	-896.1	13.961

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Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Hot Fluid Physical Property Data

Pressure Set, 485.30 psig

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Enthalpy Btu/lb	Liquid Surface Tension dyne/cm
189.00	--	--	--	--
200.00	0.0561	0.5763	-880.3	13.298

Cold Fluid Property Data

Fluid name	Cooling Water
Physical property method	Use property generator
Temperature interpolation option	Program
Flash type	Integral
Critical point composition basis	Local liquid phase
Quantity units	Moles
Number of components	1
Property package	HTRI Fluid Properties (new)

Cold Fluid Component Data

Component number	1
Component name	Water
Comp. bank name	Water
Component bank	HTRI Fluid Properties (new)
Component code	42
Component phase	Mixed

Cold Fluid User-Specified Conditions for Property Generation

Point option	Defined P and T ranges	
Starting pressure	60.000	psig
Ending pressure	50.000	psig
Starting temperature	80.00	F
Ending temperature	130.00	F
Vapor fraction / enthalpy basis	Mole/mole fraction	
Increment option	Equal Enthalpy	
Pressure sets	Auto	
Temperature points	Auto	
Minimum number of 2-phase points	Auto	
Logic for regenerating properties	If associated input changes	
Regenerate properties on next run	No	
Supercritical phase	Liquid	
Insert bubble point	Yes	
Insert dew point	Yes	
Create 2-phase zones	Yes	
Adjust calculated points	Yes	
Generate latent heat	No	

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Corn Oil Jet Mode - EOR : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Control Name Data

Case name	Corn Oil Jet Mode - EOR
Item Number	18-X-356
Revision	02
Service	Vapor Cooler

Control Methods Data

Shellside friction factor method	Commercial	
Tubeside friction factor method	Commercial	
Pure longitudinal flow	No	
Pure component condensation	No	
Condensing correlation	HTRI Proration	
Mole fraction inerts	0.0000	
Momentum exclusion	0.0000	%
Perform shellside subcooling calculations	No	
Pure component boiling	No	
Check film boiling	Yes	
Nucleate boiling method	Physical property/theoretical boiling range	
Component boiling method	Nucleate and convective	
Increments per baffle	Calculated	

Control User-Defined Methods Data

Add non-nucleate boiling	Yes