FABSCO
SHELL & TUBE, LLC

Member HTRI

HEAT EXCHANGER SPECIFICATION SHEET

US Units

Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Job No.	S-16030-9-18-X-373REV3
Address	ALLENTOWN, PA	P.O. No.	4505600057
Plant Location	PARAMOUNT, CA	Fabsco Job	S21-13258-11
Service of Unit	LEAN OIL COOLER	Date	08/22/2022 Rev. D
Size	15.375 x 170 inch Type AEU Horizontal	Item No.	18-X-373
Surf/Unit (Gross/Eff)	333.79 / 327.66 ft2 Shell/Unit 1	Connected In	1 Parallel 1 Series
		Surf/Shell (Gross/Eff)	333.79 / 327.66 ft2

PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		DEBUTANIZED NAPTHA		COOLING WATER	
Fluid Quantity, Total	lb/hr	49482		70899	
Vapor (In/Out)					
Liquid		49482	49482	70899	70899
Steam					
Water				70899	70899
Noncondensables					
Temperature (In/Out)	F	145.00	105.00	80.00	96.02
Specific Gravity		0.6002	0.6229	0.9972	0.9944
Viscosity	cP	0.1770	0.2150	0.8572	0.7113
Molecular Weight		78.69	78.69	18.02	18.02
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	0.5890	0.5570	0.9991	0.9986
Thermal Conductivity	Btu/hr-ft-F	0.0550	0.0580	0.3526	0.3600
Latent Heat	Btu/lb				
Inlet Pressure	psig	285		50	
Velocity	ft/sec	1.65		5.64	
Pressure Drop, Allow/Calc	psi	5.000	2.284	10.000	9.974
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

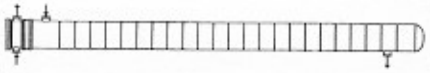
Heat Exchanged 1134137 Btu/hr MTD (Corrected) 32.3 F

Transfer Rate, Service 107.08 Btu/ft2-hr-F Clean 211.01 Btu/ft2-hr-F Actual 112.58 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

			Shell Side	Tube Side
Design/Test Pressure		psig	400/FV / CODE	310 / CODe
Design Temperature		F	300 / 300 / 32	150 / 32
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 3"-600# RF	1 @ 3"-600# RF
	Out	inch	1 @ 3"-600# RF	1 @ 3"-600# RF
	Intermediate			

Sketch (Bundle/Nozzle Orientation)



Tube No. 60 U's OD 0.7500 inch Thk(Min) 0.083 inch Length 14.167 ft Pitch 1.0000 inch

Tube Type Plain Material SA-179 Tube pattern 90

Shell SA-516-70 ID 15.375 OD 16.375 inch | Shell Cover SA-516-70N (INTEGRAL)

Channel or Bonnet SA-516-70 | Channel Cover SA-516-70N (REMOVABLE)

Tubesheet-Stationary SA-516-70N | Tubesheet-Floating

Floating Head Cover | Impingement Plate RODS (2 ROWS x 0.625" OD)

Baffles-Cross SA-516-70 (VERT. CUT) Type SINGLE SEG. %Cut (Diam) 22.34 Spacing(c/c) 7.0000 Inlet 13.750 inch

Baffles-Long Seal Type

Supports-Tube 23 Cross Passes U-Bend Type FULL SUPPORT

Bypass Seal Arrangement 2 Pair Seal Strips & 4 Dummy Tubes Tube-Tubesheet Joint SEAL-WELD, ROLL & EXPAND (2 GROOVES)

Expansion Joint Type

Rho-V2-Inlet Nozzle 3577.1 lb/ft-sec2 Bundle Entrance 54.56 Bundle Exit 407.54 lb/ft-sec2

Gaskets - .175" THK. TP316 S/S SPIRAL WOUND GRAPHITE FILLED W/ TP316 S/S INNER & OUTER COMPRESSION RINGS

Code Requirements ASME SECTION VIII, DIV. 1 NATIONAL BOARD TEMA Class R API 660

Weight/Shell 4,100. lb Filled with Water 5,300. lb Bundle 1,500. lb

1. CORN OIL JET MODE - EOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED. 2. FLOWS & DUTY INCREASED BY 10%.

3. PROVIDE (1)2"-300# RFLWN W/ BLIND IN EACH PROCESS NOZZLE.

4. PROVIDE (2)2"-300# RFLWN W/ BLIND IN CHANNEL FOR VENT & DRAIN.

5. STRESS RELIEVE U-BENDS + 1' S.L. 6. SHELL-SIDE IS IN FLAMMABLE & TOXIC SERVICE.

Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 8.2 8/22/2022 14:34 SN: 13528-113450684 **US Units**
18-X-373 CORN OIL JET MODE-EOR
LEAN OIL COOLER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

No Data Check Messages.
See Runtime Message Report for Warning Messages.

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name		DEBUTANIZED NAPTHA		COOLING WATER	
Flow rate	(1000-lb/hr)		49.482 *		70.899 *
Inlet/Outlet Y	(Wt. frac vap.)	0.0000	0.0000	0.0000	0.0000
Inlet/Outlet T	(Deg F)	145.00	105.00	80.00	96.02
Inlet P/Avg	(psia)	299.70	298.56	64.700	59.713
dP/Allow.	(psi)	2.284	5.000	9.974	10.000
Fouling	(ft2-hr-F/Btu)		0.00150		0.00200

Exchanger Performance

Shell h	(Btu/ft2-hr-F)	283.70	Actual U	(Btu/ft2-hr-F)	112.58
Tube h	(Btu/ft2-hr-F)	1437.5	Required U	(Btu/ft2-hr-F)	107.08
Hot regime	(--)	Sens. Liquid	Duty	(MM Btu/hr)	1.1341
Cold regime	(--)	Sens. Liquid	Eff. area	(ft2)	327.66
EMTD	(Deg F)	32.3	Overdesign	(%)	5.14

Shell Geometry			Baffle Geometry		
TEMA type	(--)	AEU	Baffle type		Single-Seg.
Shell ID	(inch)	15.375	Baffle cut	(Pct Dia.)	22.34
Series	(--)	1	Baffle orientation	(--)	Parallel
Parallel	(--)	1	Central spacing	(inch)	7.0000
Orientation	(deg)	0.00	Crosspasses	(--)	23

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	2.6240
Tube OD	(inch)	0.7500	Shell outlet	(inch)	2.6240
Length	(ft)	14.167	Inlet height	(inch)	1.5001
Pitch ratio	(--)	1.3333	Outlet height	(inch)	1.6250
Layout	(deg)	90	Tube inlet	(inch)	2.6240
Tubecount	(--)	120	Tube outlet	(inch)	2.6240
Tube Pass	(--)	4			

Thermal Resistance, %	
Shell	39.68
Tube	10.35
Fouling	46.65
Metal	3.32

Velocities, ft/sec	Min	Max
Tubeside	5.63	6.46
Crossflow	1.16	2.09
Longitudinal	1.45	1.73

Flow Fractions	
A	0.155
B	0.528
C	0.033
E	0.135
F	0.150

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Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

The outlet baffle spacing is less than the calculated minimum outlet spacing 7 in. (177 mm) using estimated nozzle clearance requirements. This could result in the last baffle being placed beneath or beyond the outlet nozzle. This geometry is not recommended.

The physical properties of the hot fluid have been extrapolated beyond the valid temperature range. Check the calculated values. The thermal analysis requires properties at bulk and skin/wall temperatures.

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.

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

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

Bundle-to-shell clearance set by user, is less than required. OTL based only upon user specified clearance. Construction may not be possible.

Final Results

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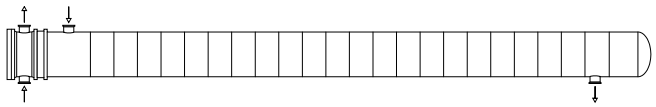
LEAN OIL COOLER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Process Data		Hot Shellside		Cold Tubeside	
Fluid name		DEBUTANIZED NAPTHA		COOLING WATER	
Fluid condition			Sens. Liquid		Sens. Liquid
Total flow rate	(1000-lb/hr)		49.482 *		70.899 *
Weight fraction vapor, In/Out	(--)	0.0000	0.0000	0.0000	0.0000
Temperature, In/Out	(Deg F)	145.00	105.00	80.00	96.02
Skin temperature, Min/Max	(Deg F)	96.19	122.97	86.48	99.93
Wall temperature, Min/Max	(Deg F)	93.00	115.19	92.37	113.66
Pressure, In/Average	(psia)	299.70	298.56	64.700	59.713
Pressure drop, Total/Allowed	(psi)	2.284	5.000	9.974	10.000
Velocity, Mid/Max allow	(ft/sec)	1.65		5.64	
Mole fraction inert	(--)				
Average film coef.	(Btu/ft2-hr-F)		283.70		1437.5
Heat transfer safety factor	(--)		1.0000		1.0000
Fouling resistance	(ft2-hr-F/Btu)		0.00150		0.00200

Overall Performance Data

Overall coef., Reqd/Clean/Actual	(Btu/ft2-hr-F)	107.08	/	211.01	/	112.58
Heat duty, Calculated/Specified	(MM Btu/hr)	1.1341	/			
Effective overall temperature difference	(Deg F)	32.3				
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	32.6	*	0.9926	*	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	14.506
Approximate tubeside	(ft3)	4.535

Shell Construction Information

TEMA shell type	AEU				
Shells Series	1 Parallel	1	Shell ID	(inch)	15.375
Passes Shell	1 Tube	4	Total area	(ft2)	333.79
Shell orientation angle (deg)	0.00		Eff. area	(ft2/shell)	327.66
Impingement present	Rods		Impingement rod rows		2
Pairs seal strips	2		Passlane seal rods (inch)	0.3750	No. 4
Shell expansion joint	No		UBend tangent to Support Dist. (inch)		1.1250

Weight estimation Wet/Dry/Bundle 4781.2 / 3593.0 / 1588.7 (lb/shell)

Baffle Information

Type	Parallel	Single-Seg.
Crosspasses/shellpass		23
Central spacing	(inch)	7.0000
Inlet spacing	(inch)	13.750
Outlet spacing	(inch)	6.1242
Baffle thickness	(inch)	0.2500
Use deresonating baffles		No

Baffle cut (% dia) 22.34

No.	(Pct Area)	(inch) to C.L
1	16.71	4.2527
2	0.00	0.0000

Tube Information

Tube type		Plain	Tubecount per shell		120
Length to tangent	(ft)	14.167	Pct tubes removed (both)		16.67
Effective length	(ft)	13.906	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	2.0000	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

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Shellside Performance

Nom vel, X-flow/window 1.94 / 2.33

Flow fractions for heat transfer 0.641
A=0.1546 B=0.5279 C=0.0328 E=0.1352 F=0.1495

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
0.974	0.911	1.069	0.981	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
35.41	21.23	5.26	Inlet	19.27	5.26
MOMENTUM		0.00	Outlet	18.82	3.36

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F

H. T. Parameters		Shell	Tube
Overall wall correction		0.986	1.005
Midpoint	Prandtl no.	4.84	5.21
Midpoint	Reynolds no.	32797	32071
Bundle inlet	Reynolds no.	20267	28865
Bundle outlet	Reynolds no.	38345	39507
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
39.68	10.35	46.65	3.32	5.14

Total fouling resistance (ft2-hr-F/Btu) 0.0041
Differential resistance (ft2-hr-F/Btu) 4.56e-4

Shell Nozzles		Inlet	Outlet	Liquid Outlet
Inlet at channel end-Yes				
Number at each position		1	1	0
Diameter	(inch)	2.6240	2.6240	
Velocity	(ft/sec)	9.77	9.42	
Pressure drop	(psi)	0.440	0.430	
Height under nozzle	(inch)	1.5001	1.6250	
Nozzle R-V-SQ	(lb/ft-sec2)	3577.1	3446.4	
Shell ent.	(lb/ft-sec2)	460.11	494.06	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	2.6240	2.6240	
Velocity	(ft/sec)	8.43	8.45	
Pressure drop	(psi)	0.525	0.335	
Nozzle R-V-SQ	(lb/ft-sec2)	4419.7	4432.1	

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

Diametral Clearances (inch)

Baffle-to-shell	Bundle-to-shell	Tube-to-baffle
0.1250	0.3263	0.0313

Supplementary Results

Released to the following HTRI Member Company:
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Xist 8.2 8/22/2022 14:34 SN: 13528-113450684 **US Units**
18-X-373 CORN OIL JET MODE-EOR
LEAN OIL COOLER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

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	121.31 (F)
Tubesheet temperature	300.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	98.36	99.61	99.04
2	100.71	101.85	101.33
3	103.38	104.37	103.92
4	104.86	105.76	105.35

Vibration Analysis

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LEAN OIL COOLER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Shellside condition		Sens. Liquid	(Level 2.3000)	
Axial stress loading	(1000-psi)	0.000	Added mass factor	1.394
Beta		2.717		

Position In The Bundle		**Inlet**	**Center**	**Outlet**
Length for natural frequency	(ft)	1.729	1.167	1.094
Length/TEMA maximum span	(--)	0.346	0.233	0.219
Number of spans	(--)	12	12	12
Tube natural frequency	(Hz)	252.8 +	320.3	320.0
Shell acoustic frequency	(Hz)			
Flow Velocities		**Inlet**	**Center**	**Outlet**
Window parallel velocity	(ft/sec)	2.02	1.97	1.94
Bundle crossflow velocity	(ft/sec)	0.83	1.65	1.80
Bundle/shell velocity	(ft/sec)	0.79	0.77	0.84
Fluidelastic Instability Check		**Inlet**	**Center**	**Outlet**
Log decrement	HTRI	0.038	0.038	0.038
Critical velocity	(ft/sec)	20.88	45.39	51.40
Baffle tip cross velocity ratio	(--)	0.0357	0.0327	0.0314
Average crossflow velocity ratio	(--)	0.0399	0.0364	0.0350
Acoustic Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)			
Chen number	(--)			
Turbulent buffeting ratio	(--)			
Tube Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)	0.019	0.037	0.040
Parallel flow amplitude	(inch)	0.0000	0.0000	0.0000
Crossflow amplitude	(inch)	0.0000	0.0000	0.0000
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	6.67e-5	5.60e-5	5.19e-5
Crossflow RHO-V-SQ	(lb/ft-sec2)	25.95	105.01	126.04

Bundle Entrance/Exit (analysis at first tube row)		**Entrance**	**Exit**
Fluidelastic instability ratio	(--)	0.058	0.063
Vortex shedding ratio	(--)	0.027	0.072
Crossflow amplitude	(inch)	0.00004	0.00004
Crossflow velocity	(ft/sec)	1.21	3.24
Tubesheet to inlet/outlet support	(inch)	None	None
Shell Entrance/Exit Parameters		**Entrance**	**Exit**
Impingement device		Rods	--
Flow area	(ft2)	0.105	0.099
Velocity	(ft/sec)	3.51	3.57
Critical velocity	(ft/sec)	20.88	51.40
RHO-V-SQ	(lb/ft-sec2)	460.11	494.06

Shell type	AEU	Baffle type	Single-Seg.
Tube type	Plain	Baffle layout	Parallel
Pitch ratio	1.3333	Tube diameter, (inch)	0.7500
Layout angle	90	Tube material	SA-179 Tube (S) K01200
Number U-Bend supports		Elastic modulus, (1000-psi)	29096
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.

HEAT EXCHANGER RATING DATA SHEET

Released to the following HTRI Member Company:

ST

Al Nader

US Units

Service of Unit	LEAN OIL COOLER				Item No.	18-X-373 (CORN OIL JET MODE- EOR)			
Type	AEU	Orientation	Horizontal	Connected In	1 Parallel	1 Series			
Surf/Unit (Gross/Eff)	333.79 / 327.66 ft2	Shell/Unit	1	Surf/Shell (Gross/Eff)	333.79 / 327.66 ft2				

PERFORMANCE OF ONE UNIT

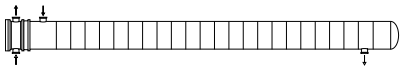
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		DEBUTANIZED NAPTHA		COOLING WATER	
Fluid Quantity, Total	1000-lb/hr	49.482		70.899	
Vapor (In/Out)	wt%	0.00	0.00	0.00	0.00
Liquid	wt%	100.00	100.00	100.00	100.00
Temperature (In/Out)	F	145.00	105.00	80.00	96.02
Density	lb/ft3	37.450	38.870	62.226	62.053
Viscosity	cP	0.1770	0.2150	0.8572	0.7113
Specific Heat	Btu/lb-F	0.5890	0.5570	0.9991	0.9986
Thermal Conductivity	Btu/hr-ft-F	0.0550	0.0580	0.3526	0.3600
Critical Pressure	psia				
Inlet Pressure	psia	299.70		64.700	
Velocity	ft/sec		1.65		5.64
Pressure Drop, Allow/Calc	psi	5.000	2.284	10.000	9.974
Average Film Coefficient	Btu/ft2-hr-F	283.70		1437.5	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	1.1341 MM Btu/hr	MTD (Corrected)	32.3 F	Overdesign	5.14 %
Transfer Rate, Service	107.08 Btu/ft2-hr-F	Calculated	112.58 Btu/ft2-hr-F	Clean	211.01 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design Pressure		psig	400.00	310.00
Design Temperature		F	300.00	150.00
No Passes per Shell			1	4
Flow Direction			Downward	Upward
Connections	In	inch	1 @ 2.6240	1 @ 2.6240
Size &	Out	inch	1 @ 2.6240	1 @ 2.6240
Rating	Liq. Out	inch	@	1 @



Tube No.	120.00	OD	0.7500 inch	Thk(Avg)	0.0913 inch	Length	14.167 ft	Pitch	1.0000 inch Tube pattern 90
Tube Type	Plain			Material	SA-179 Tube (S) K01200			Pairs seal strips	2
Shell ID	15.375 inch			Kettle ID	inch			Passlane Seal Rod No.	4
Cross Baffle Type	Parallel	Single-Seg.			%Cut (Diam)	22.34		Impingement Plate	Rods
Spacing(c/c)	7.0000 inch			Inlet	13.750 inch			No. of Crosspasses	23
Rho-V2-Inlet Nozzle	3577.1 lb/ft-sec2			Shell Entrance	460.11 lb/ft-sec2			Shell Exit	494.06 lb/ft-sec2
				Bundle Entrance	54.56 lb/ft-sec2			Bundle Exit	407.54 lb/ft-sec2
Weight/Shell	3593.0 lb			Filled with Water	4781.2 lb			Bundle	1588.7 lb

Notes:	Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
	Shell	39.68	Shellside	1.65	A	0.155
	Tube	10.35	Tubeside	5.64	B	0.528
	Fouling	46.65	Crossflow	1.94	C	0.033
Reported duty and flow rates include a user-	Metal	3.32	Window	2.33	E	0.135
specified multiplier of 1.10.					F	0.150

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Al Nader

US Units

Job No.	S-16030-9-18-X-373REV3		
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Reference No.	P.O. 4505600057
Address		Proposal No.	S21-13258-11
Plant Location	PARAMOUNT, CALIFORNIA	Date	8/22/2022 Rev D
Service of Unit	LEAN OIL COOLER	Item No.	18-X-373 (CORN OIL JET MODE- E(
Size	15.375 x 170 inch Type AEU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	333.79 / 327.66 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	333.79 / 327.66 ft2

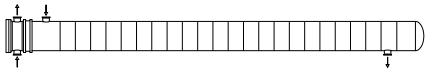
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		DEBUTANIZED NAPTHA		COOLING WATER	
Fluid Quantity, Total	lb/hr	49482		70899	
Vapor (In/Out)					
Liquid		49482	49482	70899	70899
Steam					
Water				70899	70899
Noncondensables					
Temperature (In/Out)	F	145.00	105.00	80.00	96.02
Specific Gravity		0.6002	0.6229	0.9972	0.9944
Viscosity	cP	0.1770	0.2150	0.8572	0.7113
Molecular Weight				18.02	18.02
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	0.5890	0.5570	0.9991	0.9986
Thermal Conductivity	Btu/hr-ft-F	0.0550	0.0580	0.3526	0.3600
Latent Heat	Btu/lb				
Inlet Pressure	psia	299.70		64.700	
Velocity	ft/sec	1.65		5.64	
Pressure Drop, Allow/Calc	psi	5.000	2.284	10.000	9.974
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	1134137 Btu/hr			MTD (Corrected)	32.3 F
Transfer Rate, Service	107.08 Btu/ft2-hr-F	Clean	211.01 Btu/ft2-hr-F	Actual	112.58 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	400.00 /	310.00 /
Design Temperature		F	300.00	150.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 2.6240	1 @ 2.6240
	Out	inch	1 @ 2.6240	1 @ 2.6240
	Intermediate		@	@

Tube No. 60U OD 0.7500 inch Thk(Avg) 0.0913 inch Length 14.167 ft Pitch 1.0000 inch
Tube Type Plain Material SA-179 Tube (S) K01200 Tube pattern 90
Shell SA-516 70 Pl. K02700 ID 15.375 OD 16.375 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-516 70 Pl. K02700 | Tubesheet-Floating
Floating Head Cover | Impingement Plate Rods
Baffles-Cross SA-516 70 Pl. K02700 Type Single-Seg. %Cut (Diam) 22.34 Spacing(c/c) 7.0000 Inlet 13.750 inch
Baffles-Long Seal Type None
Supports-Tube U-Bend Type Full support
Bypass Seal Arrangement 2 pairs seal strips Tube-Tubesheet Joint Expanded and seal welded (2 grooves)
Expansion Joint Type None
Rho-V2-Inlet Nozzle 3577.1 lb/ft-sec2 Bundle Entrance 54.56 Bundle Exit 407.54 lb/ft-sec2
Gaskets-Shell Side Spiral Wound Metal (SS) Tube Side Spiral Wound Metal (SS)
- Floating Head
Code Requirements TEMA Class R
Weight/Shell 3593.0 lb Filled with Water 4781.2 lb Bundle 1588.7 lb

Remarks:

Note: Reported duty and flow rates include a user-specified multiplier of 1.10.

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18-X-373 CORN OIL JET MODE-EOR
LEAN OIL COOLER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Exchanger Data

Unit identifier	Shell 1
Service type	Generic shell and tube
TEMA type	AEU
Run mode	Rating
Hot fluid location	Shellside
Unit orientation	Horizontal
Number of shells in series	1
Number of shells in parallel	1
Flow in 1st tubepass	Cocurrent
Train flow direction	Countercurrent

Construction Data

Shell material	SA-516 70 Pl. K02700	
Tube material	SA-179 Tube (S) K01200	
Shell cover material	SA-516 70 Pl. K02700	
Channel or bonnet material	SA-516 70 Pl. K02700	
Channel cover material	SA-516 70 Pl. K02700	
Tubesheet-Stationary material	SA-516 70 Pl. K02700	
Baffle-Cross material	SA-516 70 Pl. K02700	
Shellside gasket	Spiral Wound Metal (SS)	
Tubeside gasket	Spiral Wound Metal (SS)	
Shellside design pressure	400.00	psig
Tubeside design pressure	310.00	psig
Shellside vacuum pressure	Full	
Tubeside vacuum pressure	None	
Shellside design temperature	300.00	F
Tubeside design temperature	150.00	F
Shellside corrosion allowance	0.1250	inch
Tubeside corrosion allowance	0.1250	inch
Tubesheet design temperature	300.00	F
Shellside radiography	None	
Tubeside radiography	None	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	16.375	inch
Shell inside diameter	15.375	inch
Shell wall thickness	0.5000	inch
Front head outside diameter	16.375	inch
Front head inside diameter	15.375	inch
Front head thickness	0.5000	inch
Rear head outside diameter	16.375	inch
Rear head inside diameter	15.375	inch
Rear head thickness	5.0000	inch
Total tubesheet thickness	2.0000	inch
Double tubesheet	No	
Shell expansion joint	No	
Suppress mechanical calculations	No	

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Tube Data

Tube type	Plain	
Tube outside diameter	0.7500	inch
Tube wall thickness	0.0913	inch
Tube pitch	1.0000	inch
Tube pitch ratio	1.3333	
Tubepasses per shell	4	
Tube pattern	90	degrees
Number of tubes per shell	120.00	
Tube count method	Rigorous	
Tube length	14.167	ft
Tube material	SA-179 Tube (S) K01200	

Baffle Data

Baffle type	Single segmental	
Baffle orientation	Parallel	
Baffle cut percent	22.340	% shell ID
Adjust baffle cut	No adjustment	
Number of crosspasses	23	
Central baffle spacing	7.0000	inch
Inlet baffle spacing	13.750	inch
Variable baffle spacing	No	
Baffle thickness	0.2500	inch
Window cut from baffles	No	
Use deresonating baffles	No	

Supports Data

Full support at U-Bend	Full support	
Support distance to U-bend tangent	1.1250	inch
Include inlet vibration support	No	
Include outlet vibration support	No	

Nozzle Data

Shellside

Nozzle standard	01-ANSI_B36_10.TABLE			
Shell entrance type	Use impingement device			
Shell exit type	Remove tubes if TEMA requires			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	2.9990	2.9990	--	inch
Nozzle inside diameter	2.6240	2.6240	--	inch
Number at this position	1	1	--	

Tubeside

Nozzle standard	01-ANSI_B36_10.TABLE			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	2.9990	2.9990	--	inch
Nozzle inside diameter	2.6240	2.6240	--	inch
Number at this position	1	1	--	

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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	0.6250	inch
Impingement rod pitch	0.8750	inch
Impingement rods on centerline	Yes	
Impingement rod layout angle	60.00	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	Partial			
Force continuous cleaning lanes	No			
Force uniform layout	No			
Align across primary passlanes	Yes			
Fill knock out area with dummy tubes	Program set			
Fill bundle periphery with dummy tubes	Program set			
Fill passlanes with dummy tubes	No			
Square layout tube alignment	Off both c/l			
Use crossed U-bends	Yes			
Minimum U-bend diameter	2.4622			inch
Use tube layout drawing as input	Yes			
	Inlet	**Outlet**	**Liq. Outlet**	
Tube rows removed under nozzle	2	0	0	

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Clearance Data

Number of seal strip pairs	2	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	0.6250	inch
Perpendicular/horizontal passlane width	1.5000	inch
Number of passlane seal rods	4	
Passlane seal rod diameter	0.3750	inch
Tubes to remove for tie rods	None	
Number of tie rods	18	
Tie rod outside diameter	0.5000	inch
Baffle to shell clearance	0.1250	inch
Bundle to shell clearance	0.1250	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Sensible liquid	Sensible liquid	
Flow rate	44.984	64.454	1000-lb/hr
Inlet vapor fraction	0.0000	0.0000	
Outlet vapor fraction	0.0000	0.0000	
Inlet temperature	145.00	80.00	F
Outlet temperature	105.00	--	F
Inlet pressure	299.70	64.700	psia
Allowable pressure drop	5.000	10.000	psi
Duty multiplier		1.1000	

Process Fouling Data	**Hot Fluid**	**Cold Fluid**	
Fouling resistance	0.0015	0.0020	ft2-hr-F/Btu

Hot Fluid Property Data

Fluid name	DEBUTANIZED NAPTHA
Physical property method	Composition based
Temperature interpolation option	Program
Flash type	Integral
Quantity units	Moles
Number of components	1
Property package	HTRI (legacy)

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Hot Fluid Component Data

Component number	1	
Component name	[New User-Defined]	
Comp. bank name	<User-Defined>	
Component bank	HTRI (legacy)	
Component code	-1	
Component phase	Liquid	
Liquid Properties		
Reference temperature, F	145.00	105.00
Density, lb/ft3	37.450	38.870
Viscosity, cP	0.1770	0.2150
Thermal conductivity, Btu/hr-ft-F	0.0550	0.0580
Heat capacity, Btu/lb-F	0.5890	0.5570

Cold Fluid Property Data

Fluid name	COOLING WATER
Physical property method	Composition based
Temperature interpolation option	Program
Flash type	Integral
Quantity units	Moles
Number of components	1
Property package	HTRI (legacy)

Cold Fluid Component Data

Component number	1
Component name	Water (IAPWS 1997)
Comp. bank name	Water (IAPWS 1997)
Component bank	HTRI (legacy)
Component code	1
Component phase	Liquid
Component quantity	1.0000

Control Name Data

Case name	LEAN OIL COOLER
Problem name	18-X-373 CORN OIL JET MODE-EOR
Job Number	S-16030-9-18-X-373REV3
Item Number	18-X-373 (CORN OIL JET MODE- EOR)
Reference Number	P.O. 4505600057
Proposal Number	S21-13258-11
Revision	D
Service	LEAN OIL COOLER
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)
Plant	PARAMOUNT, CALIFORNIA

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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	