FABSCO
SHELL & TUBE, LLC

Member HTRI

HEAT EXCHANGER SPECIFICATION SHEET

US Units

Job No.	S-16030-10-18-X-375REV3		
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	P.O. No.	4505600058
Address	ALLENTOWN, PA	Fabsco Job	S21-13258-12
Plant Location	PARAMOUNT, CA	Date	09/26/2022 Rev. D
Service of Unit	DEPROPANIZER OVERHEAD CONDENSER	Item No.	18-X-375
Size	34 x 240 inch Type AEU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	2920.2 / 2853.2 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	2920.2 / 2853.2 ft2

PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPANE		COOLING WATER	
Fluid Quantity, Total	lb/hr	65736		363978	
Vapor (In/Out)		65736			
Liquid			65736	363978	363978
Steam					
Water				363978	363978
Noncondensables					
Temperature (In/Out)	F	125.00	110.70	80.00	104.00
Specific Gravity			0.4639	0.9972	0.9928
Viscosity	cP	0.0100	0.0840	0.8572	0.6530
Molecular Weight				18.02	18.02
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	0.5430	0.7750	0.9991	0.9985
Thermal Conductivity	Btu/hr-ft-F	0.0130	0.0480	0.3526	0.3633
Latent Heat	Btu/lb	122.20	122.20		
Inlet Pressure	psig	240		50	
Velocity	ft/sec	3.12		5.10	
Pressure Drop, Allow/Calc	psi	3.000	0.940	10.000	9.630
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

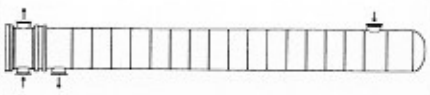
Heat Exchanged 8723167 Btu/hr MTD (Corrected) 29.7 F

Transfer Rate, Service 103.08 Btu/ft2-hr-F Clean 182.32 Btu/ft2-hr-F Actual 103.86 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design/Test Pressure		psig	360/FV / CODE	280 / CODE
Design Temperature		F	400 / 300 / -45	150 /32
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 8"-600# RF	1 @ 8"-600# RF
	Out	inch	1 @ 8"-600# RF	1 @ 8"-600# RF
	Intermediate			



Tube No. 372 U's OD 0.7500 inch Thk(Min) 0.083 inch Length 20.00 ft Pitch 1.0000 inch

Tube Type Plain Material SA-334-6 (SEAMLESS) Tube pattern 90

Shell SA-516-70N ID 34.00 inch Shell Cover SA-516-70N (INTEGRAL)

Channel or Bonnet SA-516-70N Channel Cover SA-350-LF2 CL. 1 (REMOVABLE)

Tubesheet-Stationary SA-350-LF2 CL. 1 Tubesheet-Floating

Floating Head Cover Impingement Plate RODS (2 ROWS X 0.75" OD)

Baffles-Cross SA-516-70 (VERT. CUT) Type SINGLE SEG. %Cut (Diam) 24.63 Spacing(c/c) 13.375 Inlet 13.750 inch

Baffles-Long Seal Type

Supports-Tube 17 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 1350.6 lb/ft-sec2 Bundle Entrance 501.26 Bundle Exit 33.20 lb/ft-sec2

Gaskets - .175" THK. TP 304 S/S SPIRAL WOUND GRAPHITE FILLED W/ TP304 S/S INNER & OUTER COMPRESSION RINGS

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

Weight/Shell 20,550. lb Filled with Water 28,900. lb Bundle 11,750. lb

1. CORN OIL JET MODE - EOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED. 2. FLOWS & DUTY INCREASED BY 20%.
3. PROVIDE (1)2"-300# RFLWN W/ BLIND IN EACH PROCESS NOZZLE. 4. STRESS RELIEVE U-BENDS + 1' S.L.
5. PROVIDE (2)2"-300# RFLWN W/ BLIND IN CHANNEL FOR VENT & DRAIN.
6. FLAMMABLE SERVICE SHELL-SIDE; TOXIC SERVICE TUBE-SIDE.

FABSCO SHELL & TUBE, LLC • P.O. BOX 988 • SAPULPA, OKLAHOMA 74066
TELEPHONE (918) 224-7550 • FAX (918) 224-3564

Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

See Data Check Messages Report for Warning Messages.
See Runtime Message Report for Warning Messages.

Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			PROPANE		COOLING WATER
Flow rate	(1000-lb/hr)		65.736 *		363.98 *
Inlet/Outlet Y	(Wt. frac vap.)	1.0000	0.0000	0.0000	0.0000
Inlet/Outlet T	(Deg F)	125.00	110.70	80.00	104.00
Inlet P/Avg	(psia)	254.70	254.23	64.700	59.885
dP/Allow.	(psi)	0.940	3.000	9.630	10.000
Fouling	(ft2-hr-F/Btu)		0.00150		0.00200

Exchanger Performance					
Shell h	(Btu/ft2-hr-F)	240.80	Actual U	(Btu/ft2-hr-F)	103.86
Tube h	(Btu/ft2-hr-F)	1272.5	Required U	(Btu/ft2-hr-F)	103.08
Hot regime	(--)	Inter	Duty	(MM Btu/hr)	8.7232
Cold regime	(--)	Sens. Liquid	Eff. area	(ft2)	2853.2
EMTD	(Deg F)	29.7	Overdesign	(%)	0.75

Shell Geometry			Baffle Geometry		
TEMA type	(--)	AEU	Baffle type		Single-Seg.
Shell ID	(inch)	34.000	Baffle cut	(Pct Dia.)	24.63
Series	(--)	1	Baffle orientation	(--)	Parallel
Parallel	(--)	1	Central spacing	(inch)	13.375
Orientation	(deg)	0.00	Crosspasses	(--)	17

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	7.6250
Tube OD	(inch)	0.7500	Shell outlet	(inch)	7.6250
Length	(ft)	20.00	Inlet height	(inch)	1.3229
Pitch ratio	(--)	1.3333	Outlet height	(inch)	2.1449
Layout	(deg)	90	Tube inlet	(inch)	7.6250
Tubecount	(--)	744	Tube outlet	(inch)	7.6250
Tube Pass	(--)	4			

Thermal Resistance, %		Velocities, ft/sec			Flow Fractions	
Shell	43.13		Min	Max	A	0.228
Tube	10.79	Tubeside	4.88	5.10	B	0.561
Fouling	43.04	Crossflow	0.50	8.03	C	0.011
Metal	3.05	Longitudinal	0.36	4.21	E	0.115
					F	0.085

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Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Vapor density (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor viscosity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor thermal conductivity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor heat capacity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Liquid density (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Liquid viscosity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Liquid thermal conductivity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Liquid heat capacity (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Mixture latent heat (hot,ibar 1): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor density (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor viscosity (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor thermal conductivity (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Vapor heat capacity (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Liquid density (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

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Liquid thermal conductivity (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Data Check Messages

Released to the following HTRI Member Company:
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Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Liquid heat capacity (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Mixture latent heat (hot,ibar 2): not all profile points were input. Value(s) will be assigned. Please ensure that both dew and bubble point data (at vapor fractions of 1 and 0) of both the liquid and vapor phases are specified.

Runtime Messages

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Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

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.

Final Results

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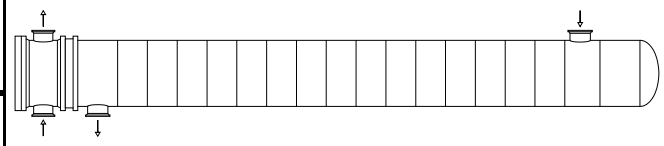
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Process Data			Hot Shellside		Cold Tubeside	
Fluid name			PROPANE		COOLING WATER	
Fluid condition			Cond. Vapor		Sens. Liquid	
Total flow rate	(1000-lb/hr)		65.736 *		363.98 *	
Weight fraction vapor, In/Out	(--)	1.0000	0.0000		0.0000	0.0000
Temperature, In/Out	(Deg F)	125.00	110.70		80.00	104.00
Skin temperature, Min/Max	(Deg F)	95.13	119.70		83.16	106.15
Wall temperature, Min/Max	(Deg F)	91.09	114.18		90.29	113.10
Pressure, In/Average	(psia)	254.70	254.23		64.700	59.885
Pressure drop, Total/Allowed	(psi)	0.940	3.000		9.630	10.000
Velocity, Mid/Max allow	(ft/sec)	3.12			5.10	
Mole fraction inert	(--)		0.0000			
Average film coef.	(Btu/ft2-hr-F)		240.80			1272.5
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)	103.08 /	182.32 /	103.86	
Heat duty, Calculated/Specified	(MM Btu/hr)	8.7232 /			
Effective overall temperature difference	(Deg F)	29.7			
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	29.8 *	0.9950 *	1.0000	

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	94.088
Approximate tubeside	(ft3)	40.293

Shell Construction Information

TEMA shell type		AEU		Shell ID	(inch)	34.000
Shells Series	1	Parallel	1	Total area	(ft2)	2920.2
Passes Shell	1	Tube	4	Eff. area	(ft2/shell)	2853.2
Shell orientation angle (deg)		0.00				
Impingement present		Rods		Impingement rod rows		2
Pairs seal strips		2		Passlane seal rods (inch)	0.5000	No. 4
Shell expansion joint		No		UBend tangent to Support Dist. (inch)		2.0000
Weight estimation Wet/Dry/Bundle		27999 /	19614 /	12366 (lb/shell)		

Baffle Information

Type		Parallel Single-Seg.	Baffle cut (% dia)	24.63	
Crosspasses/shellpass		17	No.	(Pct Area)	(inch) to C.L
Central spacing	(inch)	13.375	1	18.86	8.6258
Inlet spacing	(inch)	13.750	2	0.00	0.0000
Outlet spacing	(inch)	20.000			
Baffle thickness	(inch)	0.3125			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		744
Length to tangent	(ft)	20.00	Pct tubes removed (both)		8.06
Effective length	(ft)	19.531	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	3.5000	Wall thickness	(inch)	0.0913
Area ratio	(out/in)	1.3218	Pitch (inch) 1.0000	Ratio	1.3333
Tube metal		SA-334 6 Tube (S) K03008	Tube pattern (deg)		90

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Shellside Performance

Nom vel, X-flow/window 4.49 / 4.61

Flow fractions for vapor phase
A=0.2281 B=0.5611 C=0.0108 E=0.1148 F=0.0852

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
0.983	0.918	1.071	0.977	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
55.71	10.49	11.94	Inlet	25.67	2.01
MOMENTUM		-5.88	Outlet	2.06	1.29

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
RPM	Shear	Inter	Sens Liq	0.9771

H. T. Parameters		Shell	Tube
Overall wall correction			1.001
Midpoint	Prandtl no.		4.91
Midpoint	Reynolds no.	24451	30496
Bundle inlet	Reynolds no.	175074	26032
Bundle outlet	Reynolds no.	13775	32598
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
43.13	10.79	43.04	3.05	0.75

Total fouling resistance	(ft2-hr-F/Btu)		0.0041
Differential resistance	(ft2-hr-F/Btu)		7.27e-5

Shell Nozzles		Inlet	Outlet	Liquid Outlet
Inlet at channel end-No				
Number at each position		1	1	0
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	23.46	1.99	
Pressure drop	(psi)	0.241	0.019	
Height under nozzle	(inch)	1.3229	2.1449	
Nozzle R-V-SQ	(lb/ft-sec2)	1350.6	114.53	
Shell ent.	(lb/ft-sec2)	1079.3	71.96	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	5.12	5.15	
Pressure drop	(psi)	0.194	0.124	
Nozzle R-V-SQ	(lb/ft-sec2)	1633.7	1640.9	

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	0.34375	0.15625

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	123.26 (F)
Tubesheet temperature	400.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	98.56	99.74	99.20
2	103.38	104.36	103.92
3	106.94	107.76	107.39
4	110.32	110.99	110.69

Vibration Analysis

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Shellside condition	Cond. Vapor	(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)	2.260	2.229	2.781
Length/TEMA maximum span	(--)	0.452	0.446	0.556
Number of spans	(--)	9	9	9
Tube natural frequency	(Hz)	98.3	97.6	91.7 +
Shell acoustic frequency	(Hz)	120.6 +		
Flow Velocities		**Inlet**	**Center**	**Outlet**
Window parallel velocity	(ft/sec)	7.57	3.62	0.64
Bundle crossflow velocity	(ft/sec)	6.54	3.30	0.38
Bundle/shell velocity	(ft/sec)	3.95	1.89	0.22
Fluidelastic Instability Check		**Inlet**	**Center**	**Outlet**
Log decrement	HTRI	0.030	0.047	0.038
Critical velocity	(ft/sec)	36.50	32.66	8.44
Baffle tip cross velocity ratio	(--)	0.1739	0.0980	0.0439
Average crossflow velocity ratio	(--)	0.1790	0.1009	0.0451
Acoustic Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)	0.349		
Chen number	(--)	17354		
Turbulent buffeting ratio	(--)	0.230		
Tube Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)	0.403	0.203	0.024
Parallel flow amplitude	(inch)	0.0000	0.0000	0.0000
Crossflow amplitude	(inch)	0.0002	0.0001	0.0000
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	9.36e-4	4.11e-4	7.21e-5
Crossflow RHO-V-SQ	(lb/ft-sec2)	104.87	55.66	4.20

Bundle Entrance/Exit (analysis at first tube row)		Entrance	Exit
Fluidelastic instability ratio	(--)	0.391	0.127
Vortex shedding ratio	(--)	0.882	0.066
Crossflow amplitude	(inch)	0.00422	0.00014
Crossflow velocity	(ft/sec)	14.29	1.07
Tubesheet to inlet/outlet support	(inch)	None	None
Shell Entrance/Exit Parameters		**Entrance**	**Exit**
Impingement device		Rods	--
Flow area	(ft2)	0.355	0.400
Velocity	(ft/sec)	20.97	1.58
Critical velocity	(ft/sec)	36.50	8.44
RHO-V-SQ	(lb/ft-sec2)	1079.3	71.96

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-334 1 Tube (S) K03008
Number U-Bend supports		Elastic modulus, (1000-psi)	29204
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	DEPROPANIZER OVERHEAD CONDENSER			Item No.	18-X-375 (CORN OIL JET MODE-EOR)		
Type	AEU	Orientation	Horizontal	Connected In	1 Parallel	1 Series	
Surf/Unit (Gross/Eff)	2920.2 / 2853.2 ft2	Shell/Unit	1	Surf/Shell (Gross/Eff)	2920.2 / 2853.2 ft2		

PERFORMANCE OF ONE UNIT

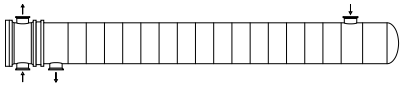
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPANE		COOLING WATER	
Fluid Quantity, Total	1000-lb/hr	65.736		363.98	
Vapor (In/Out)	wt%	100.00	0.00	0.00	0.00
Liquid	wt%	0.00	100.00	100.00	100.00
Temperature (In/Out)	F	125.00	110.70	80.00	104.00
Density	lb/ft3	2.4550	28.950	62.226	61.952
Viscosity	cP	0.0100	0.0840	0.8572	0.6530
Specific Heat	Btu/lb-F	0.5430	0.7750	0.9991	0.9985
Thermal Conductivity	Btu/hr-ft-F	0.0130	0.0480	0.3526	0.3633
Critical Pressure	psia				
Inlet Pressure	psia	254.70		64.700	
Velocity	ft/sec		3.12		5.10
Pressure Drop, Allow/Calc	psi	3.000	0.940	10.000	9.630
Average Film Coefficient	Btu/ft2-hr-F	240.80		1272.5	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	8.7232 MM Btu/hr	MTD (Corrected)	29.7 F	Overdesign	0.75 %
Transfer Rate, Service	103.08 Btu/ft2-hr-F	Calculated	103.86 Btu/ft2-hr-F	Clean	182.32 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design Pressure		psig	360.00	280.00
Design Temperature		F	400.00	150.00
No Passes per Shell			1	4
Flow Direction			Downward	Upward
Connections	In	inch	1 @ 7.6250	1 @ 7.6250
Size &	Out	inch	1 @ 7.6250	1 @ 7.6250
Rating	Liq. Out	inch	@	1 @



Tube No.	744.00	OD	0.7500 inch	Thk(Avg)	0.0913 inch	Length	20.00 ft	Pitch	1.0000 inch Tube pattern 90
Tube Type	Plain			Material	SA-334 6 Tube (S) K03008			Pairs seal strips	2
Shell ID	34.000 inch			Kettle ID	inch			Passlane Seal Rod No.	4
Cross Baffle Type	Parallel	Single-Seg.				%Cut (Diam)	24.63	Impingement Plate	Rods
Spacing(c/c)	13.375 inch			Inlet	13.750 inch			No. of Crosspasses	17
Rho-V2-Inlet Nozzle	1350.6 lb/ft-sec2			Shell Entrance	1079.3 lb/ft-sec2			Shell Exit	71.96 lb/ft-sec2
				Bundle Entrance	501.26 lb/ft-sec2			Bundle Exit	33.20 lb/ft-sec2
Weight/Shell	19614 lb			Filled with Water	27999 lb			Bundle	12366 lb

Notes:	Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
	Shell	43.13	Shellside	3.12	A	0.228
	Tube	10.79	Tubeside	5.10	B	0.561
	Fouling	43.04	Crossflow	4.49	C	0.011
Reported duty and flow rates include a user-	Metal	3.05	Window	4.61	E	0.115
specified multiplier of 1.20.					F	0.085

HEAT EXCHANGER SPECIFICATION SHEET

Released to the following HTRI Member Company:
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US Units

Job No.	S-16030-10-18-X-375REV3		
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Reference No.	P.O# 4505600058
Address		Proposal No.	S21-13258-12
Plant Location	PARAMOUNT, CALIFORNIA	Date	9/26/2022 Rev D
Service of Unit	DEPROPANIZER OVERHEAD CONDENSER	Item No.	18-X-375 (CORN OIL JET MODE-EO
Size	34 x 240 inch Type AEU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	2920.2 / 2853.2 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	2920.2 / 2853.2 ft2

PERFORMANCE OF ONE UNIT

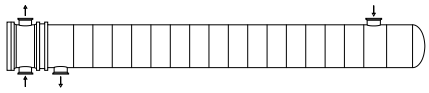
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPANE		COOLING WATER	
Fluid Quantity, Total	lb/hr	65736		363978	
Vapor (In/Out)		65736			
Liquid			65736	363978	363978
Steam					
Water				363978	363978
Noncondensables					
Temperature (In/Out)	F	125.00	110.70	80.00	104.00
Specific Gravity			0.4639	0.9972	0.9928
Viscosity	cP	0.0100	0.0840	0.8572	0.6530
Molecular Weight				18.02	18.02
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	0.5430	0.7750	0.9991	0.9985
Thermal Conductivity	Btu/hr-ft-F	0.0130	0.0480	0.3526	0.3633
Latent Heat	Btu/lb	122.20	122.20		
Inlet Pressure	psia	254.70		64.700	
Velocity	ft/sec	3.12		5.10	
Pressure Drop, Allow/Calc	psi	3.000	0.940	10.000	9.630
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	8723167 Btu/hr			MTD (Corrected)	29.7 F
Transfer Rate, Service	103.08 Btu/ft2-hr-F	Clean	182.32 Btu/ft2-hr-F	Actual	103.86 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design/Test Pressure		psig	360.00 /	280.00 /
Design Temperature		F	400.00	150.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 7.6250	1 @ 7.6250
	Out	inch	1 @ 7.6250	1 @ 7.6250
	Intermediate		@	@



Tube No.	372U	OD	0.7500	inch	Thk(Avg)	0.0913	inch	Length	20.00	ft	Pitch 1.0000 inch
Tube Type	Plain				Material	SA-334 6 Tube (S) K03008					Tube pattern 90
Shell	SA-516 70 Pl. K02700			ID	34.000	OD	35.000	inch	Shell Cover	SA-516 70 Pl. K02700	(Integ.)
Channel or Bonnet	SA-516 70 Pl. K02700								Channel Cover	SA-350LF2CL1	
Tubesheet-Stationary	SA-350LF2CL1								Tubesheet-Floating		
Floating Head Cover									Impingement Plate	Rods	
Baffles-Cross	Carbon steel			Type	Single-Seg.		%Cut (Diam)	24.63	Spacing(c/c)	13.375	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	Seal Welded & Expanded (2 grooves)					
Expansion Joint					Type	None					
Rho-V2-Inlet Nozzle	1350.6	lb/ft-sec2			Bundle Entrance	501.26		Bundle Exit	33.20	lb/ft-sec2	
Gaskets-Shell Side	304 S.S. Spiral Wound				Tube Side	304 S.S. Spiral Wound Metal					
- Floating Head											
Code Requirements									TEMA Class	R	
Weight/Shell	20550 lb			Filled with Water	28900	lb			Bundle	11750 lb	

Remarks:

Note: Reported duty and flow rates include a user-specified multiplier of 1.20.

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Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : 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	Countercurrent	
Train flow direction	Countercurrent	

Construction Data

Shell material	SA-516 70 Pl. K02700	
Tube material	SA-334-6 Tube K03008	
Shell cover material	SA-516 70 Pl. K02700	
Channel or bonnet material	SA-516 70 Pl. K02700	
Channel cover material	SA-350LF2CL1	
Tubesheet-Stationary material	SA-350LF2CL1	
Baffle-Cross material	SA-516-70	
Shellside gasket	Spiral Wound Metal (SS)	
Tubeside gasket	Spiral Wound Metal (SS)	
Shellside design pressure	360.00	psig
Tubeside design pressure	280.00	psig
Shellside vacuum pressure	Full	
Tubeside vacuum pressure	None	
Shellside design temperature	400.00	F
Tubeside design temperature	150.00	F
Shellside corrosion allowance	0.1250	inch
Tubeside corrosion allowance	0.1250	inch
Tubesheet design temperature	400.00	F
Shellside radiography	Spot	
Tubeside radiography	Spot	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	35.000	inch
Shell inside diameter	34.000	inch
Shell wall thickness	0.5000	inch
Front head outside diameter	35	inch
Front head inside diameter	34.000	inch
Front head thickness	0.5	inch
Rear head outside diameter	35.000	inch
Rear head inside diameter	34.000	inch
Rear head thickness	0.5000	inch
Total tubesheet thickness	3.5000	inch
Double tubesheet	No	
Shell expansion joint	No	
Suppress mechanical calculations	No	

Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

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
Tube count method	Rigorous	
Tube length	20.00	ft
Tube material	SA-334 6 Tube K03008	

Baffle Data

Baffle type	Single segmental	
Baffle orientation	Parallel	
Baffle cut percent	24.630	% shell ID
Adjust baffle cut	No adjustment	
Number of crosspasses	17	
Central baffle spacing	13.375	inch
Inlet baffle spacing	13.750	inch
Variable baffle spacing	No	
Window cut from baffles	No	
Use deresonating baffles	No	

Supports Data

Full support at U-Bend	Full support	
Support distance to U-bend tangent	2.0000	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	9.1250	9.1250	--	inch
Nozzle inside diameter	7.6250	7.6250	--	inch
Number at this position	1	1	--	

Tubeside

Nozzle standard	01-ANSI_B36_10.TABLE			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	8.6250	8.6250	--	inch
Nozzle inside diameter	7.6250	7.6250	--	inch
Number at this position	1	1	--	

Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Nozzle Location Data

Radial position on shell inlet nozzle	Program decides	
Longitudinal position on shell of inlet nozzle	At rear 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	0.7500	inch
Impingement rod pitch	1.6250	inch
Impingement rods on centerline	Program set	
Impingement rod layout angle	30.00	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	Program set	
Minimum U-bend diameter	2.2500	inch
Use tube layout drawing as input	Yes	

Clearance Data

Number of seal strip pairs	2	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	0.7500	inch
Perpendicular/horizontal passlane width	1.5000	inch
Number of passlane seal rods	4	
Passlane seal rod diameter	0.5000	inch
Tubes to remove for tie rods	None	
Number of tie rods	8	
Tie rod outside diameter	0.5000	inch
Baffle to shell clearance	0.1875	inch
Bundle to shell clearance	0.34375	inch
Baffle clearance type	TEMA	

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Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Two phase	Sensible liquid	
Flow rate	54.780	303.31	1000-lb/hr
Inlet vapor fraction	--	0.0000	
Outlet vapor fraction	--	0.0000	
Inlet temperature	125.00	80.00	F
Outlet temperature	110.70	--	F
Inlet pressure	254.70	64.700	psia
Allowable pressure drop	3.000	10.000	psi
Duty multiplier		1.2000	

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

Hot Fluid Property Data	
Fluid name	PROPANE
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, 254.70 psia

Temp. F	Enthalpy Btu/lb	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
125.00	-1014	1.0000	2.4550	0.0100	0.0130	0.5430	--	--
123.60	-1136	0.0000	--	--	--	--	--	--
122.20	-1137	0.0000	--	--	--	--	--	--
120.70	-1138	0.0000	--	--	--	--	--	--
119.30	-1140	0.0000	--	--	--	--	--	--
117.90	-1141	0.0000	--	--	--	--	--	--
116.40	-1142	0.0000	--	--	--	--	--	--
115.00	-1143	0.0000	--	--	--	--	--	--
113.60	-1144	0.0000	--	--	--	--	--	--
112.10	-1145	0.0000	--	--	--	--	--	--
110.70	-1146	0.0000	--	--	--	--	28.950	0.0840

Pressure Set, 254.70 psia

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Latent Heat Btu/lb
125.00	--	--	122.20
123.60	--	--	--
122.20	--	--	--
120.70	--	--	--
119.30	--	--	--

Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

Hot Fluid Physical Property Data

Pressure Set, 254.70 psia

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Latent Heat Btu/lb
117.90	--	--	--
116.40	--	--	--
115.00	--	--	--
113.60	--	--	--
112.10	--	--	--
110.70	0.0480	0.7750	--

Pressure Set, 249.70 psia

Temp. F	Enthalpy Btu/lb	Vapor Mass Fraction	Vapor Density lb/ft3	Vapor Dynamic Viscosity cP	Vapor Thermal Cond. Btu/hr-ft-F	Vapor Heat Capacity Btu/lb-F	Liquid Density lb/ft3	Liquid Dynamic Viscosity cP
125.00	-1013	1.0000	2.4068	0.0100	0.0130	0.5430	--	--
123.60	-1014	1.0000	--	--	--	--	--	--
122.20	-1137	0.0000	--	--	--	--	--	--
120.70	-1138	0.0000	--	--	--	--	--	--
119.30	-1140	0.0000	--	--	--	--	--	--
117.90	-1141	0.0000	--	--	--	--	--	--
116.40	-1142	0.0000	--	--	--	--	--	--
115.00	-1143	0.0000	--	--	--	--	--	--
113.60	-1144	0.0000	--	--	--	--	--	--
112.10	-1145	0.0000	--	--	--	--	--	--
110.70	-1146	0.0000	--	--	--	--	28.950	0.0840

Pressure Set, 249.70 psia

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F	Liquid Latent Heat Btu/lb
125.00	--	--	122.20
123.60	--	--	--
122.20	--	--	--
120.70	--	--	--
119.30	--	--	--
117.90	--	--	--
116.40	--	--	--
115.00	--	--	--
113.60	--	--	--
112.10	--	--	--
110.70	0.0480	0.7750	--

Xist 8.2 9/26/2022 9:43 SN: 13528-113450684 **US Units**
18-X-375 CORN OIL JET MODE-EOR
DEPROPANIZER OVERHEAD CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Single-Segmental Baffles

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	DEPROPANIZER OVERHEAD CONDENSER
Problem name	18-X-375 CORN OIL JET MODE-EOR
Job Number	S-16030-10-18-X-375REV3
Item Number	18-X-375 (CORN OIL JET MODE-EOR)
Reference Number	P.O# 4505600058
Proposal Number	S21-13258-12
Revision	D
Service	DEPROPANIZER OVERHEAD CONDENSER
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)
Plant	PARAMOUNT, CALIFORNIA

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