FABSCO
SHELL & TUBE, LLC
2410 Industrial Road
P.O. Box 988
Sapulpa, OK 74066
918/224-7550 Fax 918/224-3564

HEAT EXCHANGER SPECIFICATION SHEET

US Units

		Job No.	S-16030-4-18-X-359REV9
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	P.O. No.	4505600056
Address	ALLENTOWN, PA	Fabsco Job	S21-13258-4
Plant Location	PARAMOUNT, CA	Date	12/08/2022 Rev. D
Service of Unit	PRODUCT FRACTIONATOR OVERHEAD TRIM CONDENSER	Item No.	18-X-359
Size	36 x 204 inch Type AEU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	2710.4 / 2649 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	2710.4 / 2649 ft2

PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PRODUCT FRACTIONATOR OH VAPOR		COOLING WATER	
Fluid Quantity, Total	lb/hr	135600		425000	
Vapor (In/Out)		34802	7194.0		
Liquid		100798	128406	425000	425000
Steam					
Water				425000	425000
Noncondensables					
Temperature (In/Out)	F	165.00	105.04	80.00	99.95
Specific Gravity		0.6248	0.6469	0.9972	0.9937
Viscosity	cP	0.0090 V/L 0.2200	0.0120 V/L 0.2690	0.8572	0.6816
Molecular Weight				18.02	18.02
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	0.4720 V/L 0.5760	0.4920 V/L 0.5360	0.9990	0.9985
Thermal Conductivity	Btu/hr-ft-F	0.0160 V/L 0.0560	0.0290 V/L 0.0590	0.3526	0.3617
Latent Heat	Btu/lb	160.98	155.69		
Inlet Pressure	psig	16		60	
Velocity	ft/sec	9.31		5.33	
Pressure Drop, Allow/Calc	psi	1.000	0.928	10.000	9.700
Fouling Resistance (min)	ft2-hr-F/Btu	0.00200		0.00200	

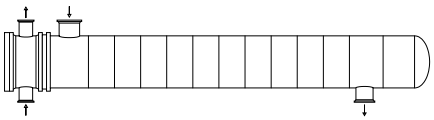
Heat Exchanged 8466122 Btu/hr MTD (Corrected) 39.4 F

Transfer Rate, Service 81.14 Btu/ft2-hr-F Clean 134.07 Btu/ft2-hr-F Actual 82.63 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design/Test Pressure		psig	125/FV / CODE	120 / 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 @ 12"-300# RF	1 @ 8"-300# RF
	Out	inch	1 @ 10"-300# RF	1 @ 8"-300# RF
	Intermediate			



Tube No. 406 U's OD 0.7500 inch Thk(Min) 0.083 inch Length 17.000 ft Pitch 1.0000 inch

Tube Type Plain Material SA-179 Tube pattern 90

Shell	SA-516-70 ID 36.00 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 0.75" OD)

Baffles-Cross SA-36 (VERT. CUT) Type DOUBLE SEG %Cut (Diam) 26.04 Spacing(c/c) 15.625 Inlet 25.000 inch

Baffles-Long Seal Type

Supports-Tube 12 Cross Passes U-Bend Type FULL SUPPORT

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

Expansion Joint Type

Rho-V2-Inlet Nozzle 2188.3 lb/ft-sec2 Bundle Entrance 1137.0 Bundle Exit 791.15 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 20,200. lb Filled with Water 29,000. lb Bundle 10,500. lb

1. CORN OIL JET MODE - EOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED.
2. PROVIDE (1)2"-300# RFLWN W/ BLIND IN EACH PROCESS NOZZLE. 3. STRESS RELIEVE U-BENDS + 1' S.L.
4. PROVIDE (2)2"-300# RFLWN W/ BLIND IN CHANNEL FOR VENT & DRAIN. 5. FLAMMABLE SERVICE SHELL-SIDE.
6. PROVIDE PARTIAL TUBE SUPPORT IN SHELL INLET , UNDER NOZZLE, SUPPORTING (4)FOUR TUBE ROWS.
7. 100% RADIOGRAPHY ON ALL BUTT-WELDS.

Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 9 (64 bit) 12/8/2022 8:31 SN: 13528-113450684 **US Units**
18-X-359 CORN OIL JET MODE- EOR
PRODUCT FRACTIONATOR OH TRIM CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-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		PRODUCT FRACTIONATOR OVERHEAD VAPOR		COOLING WATER	
Total flow rate	(1000-lb/hr)		135.60		425.00
Inlet/Outlet Y	(Wt. frac vap.)	0.2567	0.0531	0.0000	0.0000
Inlet/Outlet T	(Deg F)	165.00	105.04	80.00	99.95
Inlet P/Avg	(psia)	30.700	30.236	74.700	69.850
dP/Allow.	(psi)	0.928	1.000	9.700	10.000
Fouling	(ft2-hr-F/Btu)		0.00200		0.00200

Exchanger Performance					
Shell h	(Btu/ft2-hr-F)	162.22	Actual U	(Btu/ft2-hr-F)	82.63
Tube h	(Btu/ft2-hr-F)	1324.3	Required U	(Btu/ft2-hr-F)	81.14
Hot regime	(--)	Inter	Total duty	(MM Btu/hr)	8.4661
Cold regime	(--)	Sens. Liquid	Eff. area	(ft2)	2649.0
EMTD	(Deg F)	39.4	Overdesign	(%)	1.83

Shell Geometry			Baffle Geometry		
TEMA type	(--)	AEU	Baffle type		Double-Seg.
Shell ID	(inch)	36.000	Baffle cut	(Pct Dia.)	26.04
Series	(--)	1	Baffle orientation	(--)	Parallel
Parallel	(--)	1	Central spacing	(inch)	15.625
Orientation	(deg)	0.00	Crosspasses	(--)	12

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	11.750
Tube OD	(inch)	0.7500	Shell outlet	(inch)	9.7500
Length	(ft)	17.000	Inlet height	(inch)	2.6563
Pitch ratio	(--)	1.3333	Outlet height	(inch)	3.9375
Layout	(deg)	90	Tube inlet	(inch)	7.6250
Tubecount	(--)	812	Tube outlet	(inch)	7.6250
Tube Pass	(--)	4			

Thermal Resistance, %	
Shell	50.94
Tube	8.25
Fouling	38.37
Metal	2.45

Velocities, ft/sec	Min	Max
Tubeside	5.32	5.34
Crossflow	5.83	14.29
Longitudinal	5.68	14.79

Flow Fractions	
A	0.061
B	0.712
C	0.026
E	0.106
F	0.094

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PRODUCT FRACTIONATOR OH TRIM CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-Segmental Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Fluid Properties

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. (MN 706 104)

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. (MN 707 104)

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. (MN 708 104)

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. (MN 709 104)

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. (MN 713 104)

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. (MN 714 104)

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. (MN 715 104)

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. (MN 716 104)

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. (MN 706 104)

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. (MN 707 104)

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. (MN 708 104)

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. (MN 709 104)

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. (MN 713 104)

Liquid 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. (MN 714 104)

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. (MN 715 104)

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. (MN 716 104)

Xist 9 (64 bit) 12/8/2022 8:31 SN: 13528-113450684 **US Units**
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PRODUCT FRACTIONATOR OH TRIM CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-Segmental Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Geometry, Mechanical Design, and Vibration

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. (MN 3505)

The areas in the window for multi-segmental baffles are not equal. Check the specified baffle cut and overlap. The program uses the average window area for calculating shellside pressure drop and heat transfer. (MN 3031)

The inlet baffle spacing is less than the calculated minimum inlet spacing 25.625 in. (650 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. (MN 3036)

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. (MN 0042)

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. (MN 10170)

Fluid Properties

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. (MN 5033)

Final Results

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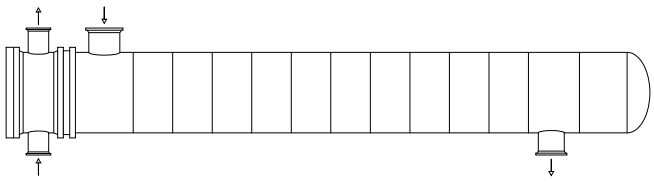
Process Data		Hot Shellside		Cold Tubeside	
Fluid name		PRODUCT FRACTIONATOR OVERHEAD VAPOR		COOLING WATER	
Fluid condition			Cond. Vapor		Sens. Liquid
Total flow rate	(1000-lb/hr)		135.60		425.00
Weight fraction vapor, In/Out	(--)	0.2567	0.0531	0.0000	0.0000
Temperature, In/Out	(Deg F)	165.00	105.04	80.00	99.95
Skin temperature, Min/Max	(Deg F)	95.32	129.62	86.28	104.45
Wall temperature, Min/Max	(Deg F)	92.01	119.43	91.52	117.92
Pressure, In/Average	(psia)	30.700	30.236	74.700	69.850
Pressure drop, Total/Allowed	(psi)	0.928	1.000	9.700	10.000
Velocity, Mid/Max allow	(ft/sec)	9.31		5.33	
Mole fraction inert	(--)		0.0000		
Average film coef.	(Btu/ft2-hr-F)		162.22		1324.3
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)	81.14	/ 134.07	/	82.63
Heat duty, Calculated/Specified	(MM Btu/hr)	8.4661	/		
Effective overall temperature difference	(Deg F)	39.4			
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	39.8	* 0.9896	*	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	95.767
Approximate tubeside	(ft3)	37.751

Shell Construction Information

TEMA shell type	AEU		Shell ID	(inch)	36.000
Shells Series	1 Parallel	1	Total area	(ft2)	2710.4
Passes Shell	1 Tube	4	Eff. area	(ft2/shell)	2649.0
Shell orientation angle (deg)	0.00				
Impingement present	Rods		Impingement rod rows		2
Pairs seal strips	2		Passlane seal rods (inch)	0.3750	No. 2
Shell expansion joint	No		UBend tangent to Support Dist. (inch)		2.0625
Weight estimation Wet/Dry/Bundle		24961 / 16630 / 11054 (lb/shell)			

Baffle Information

Type	Parallel	Double-Seg.	Baffle cut (% dia)	26.04	
Crosspasses/shellpass		12	No. (Pct Area)	(inch) to C.L	
Central spacing	(inch)	15.625	1 40.20	8.6256	
Inlet spacing	(inch)	25.000	2 33.51	4.6256	
Outlet spacing	(inch)	18.000	Baffle overlap	(inch)	4.0000
Baffle thickness	(inch)	0.3750			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		812
Length to tangent	(ft)	17.000	Pct tubes removed (both)		11.55
Effective length	(ft)	16.615	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	2.5625	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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Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-Segmental Baffles

Shellside Performance

Nom vel, X-flow/window 9.51 / 10.90

Flow fractions for vapor phase
A=0.0614 B=0.7124 C=0.0264 E=0.1062 F=0.0936

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
0.930	0.872	1.067	0.953	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
16.78	15.13	4.91	Inlet	40.42	2.73
MOMENTUM		-3.79	Outlet	26.55	1.74

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
RPM	Inter	Inter	Inter	0.7127

H. T. Parameters		Shell	Tube
Overall wall correction			1.006
Midpoint	Prandtl no.		5.13
Midpoint	Reynolds no.	7454	30735
Bundle inlet	Reynolds no.	6407	27356
Bundle outlet	Reynolds no.	6319	34006
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
50.94	8.25	38.37	2.45	1.83

Total fouling resistance (ft2-hr-F/Btu) 0.0046
Differential resistance (ft2-hr-F/Btu) 2.22e-4

Shell Nozzles

Inlet at channel end: Yes
Nozzle location at U-bend: Before U-bend

		Inlet	Outlet	Liquid Outlet
Number at each position		1	1	0
Diameter	(inch)	11.750	9.7500	
Velocity	(ft/sec)	43.75	23.77	
Pressure drop	(psi)	0.375	0.246	
Height under nozzle	(inch)	2.6563	3.9375	
Nozzle R-V-SQ	(lb/ft-sec2)	2188.3	1726.8	
Shell ent.	(lb/ft-sec2)	1511.1	578.71	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	5.98	6.00	
Pressure drop	(psi)	0.264	0.169	
Nozzle R-V-SQ	(lb/ft-sec2)	2227.3	2235.2	

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	0.3651	0.0313

Supplementary Results

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PRODUCT FRACTIONATOR OH TRIM CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-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	131.37 (F)
Tubesheet temperature	300.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	97.12	98.23	97.72
2	100.15	101.16	100.70
3	105.21	106.14	105.72
4	107.62	108.48	108.09

Vibration Analysis

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Shellside condition		Cond. Vapor		
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)	3.385	2.604	2.813
Length/TEMA maximum span	(--)	0.677	0.521	0.563
Number of spans	(--)	6	7	6
Tube natural frequency	(Hz)	75.4	73.8 +	75.0
Shell acoustic frequency	(Hz)			
Flow Velocities		**Inlet**	**Center**	**Outlet**
Window parallel velocity	(ft/sec)	18.33	9.91	6.86
Bundle crossflow velocity	(ft/sec)	10.11	8.96	5.22
Bundle/shell velocity	(ft/sec)	11.23	6.07	3.53
Fluidelastic Instability Check		**Inlet**	**Center**	**Outlet**
Log decrement	HTRI	0.033	0.039	0.052
Critical velocity	(ft/sec)	29.49	40.19	32.96
Baffle tip cross velocity ratio	(--)	0.3271	0.2127	0.1510
Average crossflow velocity ratio	(--)	0.3428	0.2229	0.1582
Acoustic Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)			
Chen number	(--)			
Turbulent buffeting ratio	(--)			
Tube Vibration Check		**Inlet**	**Center**	**Outlet**
Vortex shedding ratio	(--)	0.775	0.687	0.400
Parallel flow amplitude	(inch)	0.0001	0.0000	0.0000
Crossflow amplitude	(inch)	0.0027	0.0011	0.0004
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	0.0109	0.0042	0.0018
Crossflow RHO-V-SQ	(lb/ft-sec2)	116.81	169.73	83.14

Bundle Entrance/Exit (analysis at first tube row)		**Entrance**	**Exit**
Fluidelastic instability ratio	(--)	0.334	0.488
Vortex shedding ratio	(--)	2.419	1.234
Crossflow amplitude	(inch)	0.00186	0.01632
Crossflow velocity	(ft/sec)	31.53	16.09
Tubesheet to inlet/outlet support	(inch)	17.938	None
Shell Entrance/Exit Parameters		**Entrance**	**Exit**
Impingement device		Rods	--
Flow area	(ft2)	0.906	0.896
Velocity	(ft/sec)	36.35	13.76
Critical velocity	(ft/sec)	94.54	32.96
RHO-V-SQ	(lb/ft-sec2)	1511.1	578.71

Shell type	AEU	Baffle type	Double-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)	29446
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 PRODUCT FRACTIONATOR OVERHEAD TRIM CON Item No. 18-X-359(CORN OIL JET-EO

Type AEU Orientation Horizontal Connected In 1 Parallel 1 Series

Surf/Unit (Gross/Eff) 2710.4 / 2649.0 ft2 Shell/Unit 1 Surf/Shell (Gross/Eff) 2710.4 / 2649.0 ft2

PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		ODUCT FRACTIONATOR OVERHEAD VAP		COOLING WATER	
Fluid Quantity, Total	1000-lb/hr	135.60		425.00	
Vapor (In/Out)	wt%	25.67	5.31	0.00	0.00
Liquid	wt%	74.33	94.69	100.00	100.00
Temperature (In/Out)	F	165.00	105.04	80.00	99.95
Density	lb/ft3	0.3000 V/L 38.990	0.1746 V/L 40.369	62.228	62.006
Viscosity	cP	0.0090 V/L 0.2200	0.0120 V/L 0.2690	0.8572	0.6816
Specific Heat	Btu/lb-F	0.4720 V/L 0.5760	0.4920 V/L 0.5360	0.9990	0.9985
Thermal Conductivity	Btu/hr-ft-F	0.0160 V/L 0.0560	0.0290 V/L 0.0590	0.3526	0.3617
Critical Pressure	psia				
Inlet Pressure	psia	30.700		74.700	
Velocity	ft/sec		9.31		5.33
Pressure Drop, Allow/Calc	psi	1.000	0.928	10.000	9.700
Average Film Coefficient	Btu/ft2-hr-F	162.22		1324.3	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00200		0.00200	

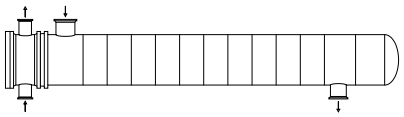
Heat Exchanged 8.4661 MM Btu/hr MTD (Corrected) 39.4 F Overdesign 1.83 %

Transfer Rate, Service 81.14 Btu/ft2-hr-F Calculated 82.63 Btu/ft2-hr-F Clean 134.07 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design Pressure		psig	125.00	120.00
Design Temperature		F	300.00	150.00
No Passes per Shell			1	4
Flow Direction			Downward	Upward
Connections	In	inch	1 @ 11.750	1 @ 7.6250
Size &	Out	inch	1 @ 9.7500	1 @ 7.6250
Rating	Liq. Out	inch	@	1 @



Tube No. 812.00 OD 0.7500 inch Thk(Avg) 0.0913 inch Length 17.000 ft Pitch 1.0000 inch Tube pattern 90

Tube Type Plain Material SA-179 Tube (S) K01200 Pairs seal strips 2

Shell ID 36.000 inch Kettle ID inch Passlane Seal Rod No. 2

Cross Baffle Type Parallel Double-Seg. %Cut (Diam 26.04 Impingement Plate Rods

Spacing(c/c) 15.625 inch Inlet 25.000 inch No. of Crosspasses 12

Rho-V2-Inlet Nozzle 2188.3 lb/ft-sec2 Shell Entrance 1511.1 lb/ft-sec2 Shell Exit 578.71 lb/ft-sec2

Bundle Entrance 1137.0 lb/ft-sec2 Bundle Exit 791.15 lb/ft-sec2

Weight/Shell 16630 lb Filled with Water 24961 lb Bundle 11054 lb

Notes:

Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
Shell	50.94	Shellside	9.31	A	0.061
Tube	8.25	Tubeside	5.33	B	0.712
Fouling	38.37	Crossflow	9.51	C	0.026
Metal	2.45	Window	10.90	E	0.106
				F	0.094

Xist 9 (64 bit) 12/8/2022 8:31 SN: 13528-113450684 **US Units**
18-X-359 CORN OIL JET MODE- EOR
PRODUCT FRACTIONATOR OH TRIM CONDENSER : Shell 1
Rating - Horizontal Multipass Flow TEMA AEU Shell With Double-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	Carbon steel	
Shellside gasket	Spiral Wound Metal (CS)	
Tubeside gasket	Spiral Wound Metal (SS)	
Shellside design pressure	125.00	psig
Tubeside design pressure	120.00	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	Full	
Tubeside radiography	Full	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	37.000	inch
Shell inside diameter	36.000	inch
Shell wall thickness	.5000	inch
Front head outside diameter	37.000	inch
Front head inside diameter	36.000	inch
Front head thickness	.5000	inch
Rear head outside diameter	37.000	inch
Rear head inside diameter	36.000	inch
Rear head thickness	.5000	inch
Total tubesheet thickness	2.5625	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
Tube count method	Rigorous	
Tube length	17.000	ft
Tube material	SA-179 Tube (S) K01200	

Baffle Data

Baffle type	Double segmental	
Baffle orientation	Parallel	
Baffle cut percent	26.040	% shell ID
Adjust baffle cut	No adjustment	
Double segmental overlap	4.0000	Tuberows
Double segmental set center baffle at inlet	Program set	
Number of crosspasses	12	
Central baffle spacing	15.625	inch
Inlet baffle spacing	25.000	inch
Variable baffle spacing	No	
Baffle thickness	0.3750	inch
Thickness at tube hole	0.3750	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	2.0625	inch
Include inlet vibration support	Yes	
Distance from tubesheet to inlet vibration support	17.938	inch
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	12.250	10.250	--	inch
Nozzle inside diameter	11.750	9.7500	--	inch
Number at this position	1	1	--	

Tubeside

Nozzle standard	01-ANSI_B36_10.TABLE			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	8.1250	8.1250	--	inch
Nozzle inside diameter	7.6250	7.6250	--	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	0.7500	inch
Impingement rod pitch	0.8125	inch
Impingement rods on centerline	Program set	
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			Yes	
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			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	
	Inlet	**Outlet**	**Liq. Outlet**	
Tube rows removed under nozzle	3	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	2	
Passlane seal rod diameter	0.3750	inch
Tubes to remove for tie rods	None	
Number of tie rods	8	
Tie rod outside diameter	0.5000	inch
Tube to baffle clearance	0.0313	inch
Baffle to shell clearance	0.1875	inch
Bundle to shell clearance	0.15625	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Two phase	Sensible liquid	
Flow rate	135.60	425.00	1000-lb/hr
Inlet vapor fraction	0.2566	0.0000	
Outlet vapor fraction	0.0530	0.0000	
Inlet temperature	--	80.00	F
Inlet pressure	30.700	74.700	psia
Allowable pressure drop	1.000	10.000	psi
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	PRODUCT FRACTIONATOR OVERHEAD VAPOR	
Physical property method	Property tables	
Temperature interpolation option	Program	
Flash type	Integral	
Quantity units	Moles	
Heat release type	Total duty from inlet	
Heat release flow rate	135.60	1000-lb/hr

Hot Fluid Physical Property Data

Pressure Set, 29.700 psia

Temp. F	Duty MM Btu/hr	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
105.00	0.0000	0.0530	0.1741	0.0120	0.0290	0.4920	40.370	0.2690
111.00	0.6200	0.0620	--	--	--	--	--	--
117.00	1.2800	0.0740	--	--	--	--	--	--
123.00	1.9800	0.0870	--	--	--	--	--	--
129.00	2.7300	0.1030	--	--	--	--	--	--

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Hot Fluid Physical Property Data

Pressure Set, 29.700 psia

Temp. F	Duty MM Btu/hr	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
135.00	3.5400	0.1220	--	--	--	--	--	--
141.00	4.4200	0.1450	--	--	--	--	--	--
147.00	5.3700	0.1720	--	--	--	--	--	--
153.00	6.3900	0.2020	--	--	--	--	--	--
159.00	7.5000	0.2380	--	--	--	--	--	--
165.00	8.6900	0.2770	0.2902	0.0090	0.0160	0.4720	38.990	0.2200

Pressure Set, 29.700 psia

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F
105.00	0.0590	0.5360
111.00	--	--
117.00	--	--
123.00	--	--
129.00	--	--
135.00	--	--
141.00	--	--
147.00	--	--
153.00	--	--
159.00	--	--
165.00	0.0560	0.5760

Pressure Set, 30.700 psia

Temp. F	Duty MM Btu/hr	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
105.00	0.0000	0.0530	0.1800	0.0120	0.0290	0.4920	40.370	0.2690
111.00	0.6100	0.0590	--	--	--	--	--	--
117.00	1.2500	0.0700	--	--	--	--	--	--
123.00	1.9400	0.0820	--	--	--	--	--	--
129.00	2.6700	0.0970	--	--	--	--	--	--
135.00	3.4600	0.1150	--	--	--	--	--	--
141.00	4.3100	0.1370	--	--	--	--	--	--
147.00	5.2400	0.1620	--	--	--	--	--	--
153.00	6.2300	0.1910	--	--	--	--	--	--
159.00	7.3100	0.2240	--	--	--	--	--	--
165.00	8.4700	0.2566	0.3000	0.0090	0.0160	0.4720	38.990	0.2200

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Hot Fluid Physical Property Data

Pressure Set, 30.700 psia

Temp. F	Liquid Thermal Cond. Btu/hr-ft-F	Liquid Heat Capacity Btu/lb-F
105.00	0.0590	0.5360
111.00	--	--
117.00	--	--
123.00	--	--
129.00	--	--
135.00	--	--
141.00	--	--
147.00	--	--
153.00	--	--
159.00	--	--
165.00	0.0560	0.5760

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	PRODUCT FRACTIONATOR OH TRIM CONDENSER
Problem name	18-X-359 CORN OIL JET MODE- EOR
Job Number	S-16030-4-18-X-359REV9
Item Number	18-X-359(CORN OIL JET-EO
Reference Number	P.O. # 4505600058
Proposal Number	S21-13258-4
Revision	D
Service	PRODUCT FRACTIONATOR OVERHEAD TRIM CONDENSER
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	
Reduced pressure calculation method	Program decides	
Increments per baffle	Calculated	

Control User-Defined Methods Data

Add non-nucleate boiling	Yes	