FABSCO SHELL & TUBE, LLC.
2410 INDUSTRIAL ROAD
SAPULPA, OK 74066
(918)224-7550 FAX(918)224-3564

Member HTRI

HEAT EXCHANGER SPECIFICATION SHEET

US Units

		Job No.	S-16030-18-X-358-TALLOWDIESELEC
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	P.O. No.	4505600056
Address	ALLENTOWN, PA	Fabsco Job	S21-13258-3
Plant Location	PARAMOUNT, CA	Date	02/06/2023 Rev. D
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358
Size	35 / 64 x 216 inch Type CKU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

PERFORMANCE OF ONE UNIT

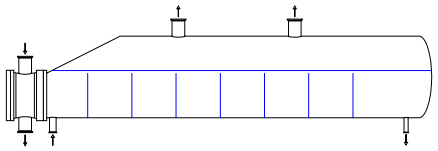
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	46398		345086	
Vapor (In/Out)			41758		
Liquid		46398	4639.8	345086	345086
Steam			41758		
Water		46398	4639.8		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	596.00	425.00
Specific Gravity		0.9540	0.8744	0.5396	0.6274
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1470	0.2921
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7740	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0500	0.0570
Latent Heat	Btu/lb	847.32	847.81		
Inlet Pressure	psig	175		110	
Velocity	ft/sec	0.48		7.08	
Pressure Drop, Allow/Calc	psi	1.500	1.290	15.000	8.946
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	42700000 Btu/hr			MTD (Corrected)	118.3 F
Transfer Rate, Service	121.99 Btu/ft2-hr-F	Clean	259.48 Btu/ft2-hr-F	Actual	125.04 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

			Shell Side	Tube Side
Design/Test Pressure		psig	/	/
Design Temperature		F		
No Passes per Shell				
Corrosion Allowance		inch		
Connections Size & Rating	In	inch		
	Out	inch		
	Intermediate			

Sketch (Bundle/Nozzle Orientation)



Tube No.	OD	inch	Thk(Min)	inch	Length	ft	Pitch	inch	
Tube Type			Material				Tube pattern		
Shell			ID	inch	Shell Cover				
Channel or Bonnet					Channel Cover				
Tubesheet-Stationary					Tubesheet-Floating				
Floating Head Cover					Impingement Plate				
Baffles-Cross		Type		%Cut (Diam)		Spacing(c/c)		Inlet	inch
Baffles-Long				Seal Type					
Supports-Tube				U-Bend				Type	
Bypass Seal Arrangement				Tube-Tubesheet Joint					
Expansion Joint				Type					
Rho-V2-Inlet Nozzle	543.79	lb/ft-sec2		Bundle Entrance		Bundle Exit		lb/ft-sec2	

Gaskets -

Code Requirements				TEMA Class	
Weight/Shell	lb	Filled with Water	lb	Bundle	lb

1. TALLOW DIESEL MODE - EOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED.

Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Process Conditions		Cold Shellside		Hot Tubeside	
Fluid name		BFW / STEAM		DIESEL PRODUCT	
Total flow rate	(1000-lb/hr)		46.398		345.09
Inlet/Outlet Y	(Wt. frac vap.)	0.0000	0.9000	0.0000	0.0000
Inlet/Outlet T	(Deg F)	225.00	377.41	596.00	425.00
Inlet P/Avg	(psia)	190.95	190.30	124.70	120.23
dP/Allow.	(psi)	1.290	1.500	8.946	15.000
Fouling	(ft2-hr-F/Btu)		0.00150		0.00200

Exchanger Performance					
Shell h	(Btu/ft2-hr-F)	1193.5	Actual U	(Btu/ft2-hr-F)	125.04
Tube h	(Btu/ft2-hr-F)	493.97	Required U	(Btu/ft2-hr-F)	121.99
Hot regime	(--)	Sens. Liquid	Total duty	(MM Btu/hr)	42.700
Cold regime	(--)	Flow	Eff. area	(ft2)	2958.9
EMTD	(Deg F)	118.3	Overdesign	(%)	2.50

Shell Geometry			Baffle Geometry		
TEMA type	(--)	CKU	Baffle type		Support
Shell ID	(inch)	35.000	Baffle cut	(Pct Dia.)	
Series	(--)	1	Baffle orientation	(--)	
Parallel	(--)	1	Central spacing	(inch)	30.000
Orientation	(deg)	0.00	Crosspasses	(--)	1

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	3.6240
Tube OD	(inch)	0.7500	Shell outlet	(inch)	7.6250
Length	(ft)	18.000	Inlet height	(inch)	1.3750
Pitch ratio	(--)	1.3333	Outlet height	(inch)	1.3750
Layout	(deg)	90	Tube inlet	(inch)	7.6250
Tubecount	(--)	828	Tube outlet	(inch)	7.6250
Tube Pass	(--)	4			

Thermal Resistance, %		Velocities, ft/sec	Min	Max	Flow Fractions	
Shell	10.48				A	0.000
Tube	33.46	Tubeside	6.74	7.78	B	0.746
Fouling	51.81	Crossflow	0.18	2.44	C	0.000
Metal	4.25	Longitudinal	--	--	E	0.000
					F	0.254

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Geometry, Mechanical Design, and Vibration

The bundle entrance and exit vibration analysis is not available for TEMA K shells. The entrance and exit areas cannot be accurately defined with information available in the program, and the nozzle flow rates often do not accurately represent the flow across the bundle due to fluid circulation. (MN 0018)

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)

Total tubesheet thickness specified is less than sum of the calculated tubesheet thicknesses. (MN 10033)

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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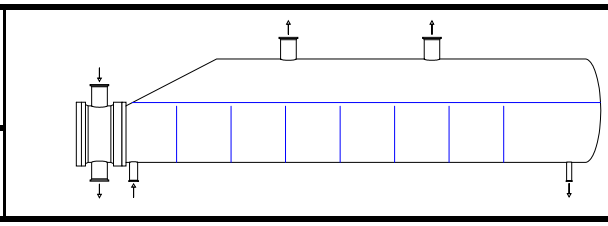
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Process Data		Cold Shellside		Hot Tubeside	
Fluid name			BFW / STEAM		DIESEL PRODUCT
Fluid condition			Boil. Liquid		Sens. Liquid
Total flow rate	(1000-lb/hr)		46.398		345.09
Weight fraction vapor, In/Out	(--)	0.0000	0.9000	0.0000	0.0000
Temperature, In/Out	(Deg F)	225.00	377.41	596.00	425.00
Skin temperature, Min/Max	(Deg F)	378.63	390.64	407.40	519.60
Wall temperature, Min/Max	(Deg F)	388.25	433.78	390.44	443.56
Pressure, In/Average	(psia)	190.95	190.30	124.70	120.23
Pressure drop, Total/Allowed	(psi)	1.290	1.500	8.946	15.000
Velocity, Mid/Max allow	(ft/sec)	0.48		7.08	
Boiling range	(Deg F)		0.0		
Average film coef.	(Btu/ft2-hr-F)		1193.5		493.97
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)	121.99	/ 259.48	/	125.04
Heat duty, Calculated/Specified	(MM Btu/hr)	42.700	/ 42.700		
Effective overall temperature difference	(Deg F)	118.3			
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	118.3	* 1.0000	*	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	354.84
Approximate tubeside	(ft3)	40.482

Shell Construction Information

TEMA shell type	CKU		Shell ID	(inch)	35.000
Shells Series	1 Parallel	1	Total area	(ft2)	3081.7
Passes Shell	1 Tube	4	Eff. area	(ft2/shell)	2958.9
Shell orientation angle (deg)	0.00		Kettle ID	(inch)	64.000
Impingement present	No				
Pairs seal strips	0		Passlane seal rods (inch)	0.7500	No. 0
Shell expansion joint	No		Full support at U-Bend	No	
Weight estimation Wet/Dry/Bundle		55163 / 30496 / 11572		(lb/shell)	

Baffle Information

Type		Support	Baffle cut (% dia)		
Crosspasses/shellpass		1	No. (Pct Area)	(inch) to C.L	
Central spacing	(inch)	30.000	1		
Inlet spacing	(inch)	27.750	2		
Outlet spacing	(inch)	0.0000	Support plates/baffle space		7
Baffle thickness	(inch)	0.6250			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		828
Length to tangent	(ft)	18.000	Pct tubes removed (both)		2.01
Effective length	(ft)	18.200	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	4.6875	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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18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Shellside Performance

Nom vel, X-flow/window	0.44 / 0.00
Kettle Recirculation Ratio (Internal/Feed)	10.13

Flow fractions for vapor phase
A=0.0000 B=0.7457 C=5.60e-6 E=0.0000 F=0.2543

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
1.050	1.000	1.050	1.000	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
90.54	0.00	0.00	Inlet	6.09	3.60
MOMENTUM		0.00	Outlet	3.37	1.97

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
PP/TBR	Subcool	Flow	Flow	

H. T. Parameters		Shell	Tube
Overall wall correction			0.985
Midpoint	Prandtl no.		7.04
Midpoint	Reynolds no.	7505	83200
Bundle inlet	Reynolds no.	7018	122959
Bundle outlet	Reynolds no.	7729	64110
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
10.48	33.46	51.81	4.25	2.50

Total fouling resistance	(ft2-hr-F/Btu)	0.0041
Differential resistance	(ft2-hr-F/Btu)	2e-4

Shell Nozzles

Inlet at channel end		Yes		
Nozzle location at U-bend		After U-bend		
		Inlet	**Outlet**	**Liquid Outlet**
Number at each position		1	2	1
Diameter	(inch)	3.6240	7.6250	2.4690
Velocity	(ft/sec)	3.02	44.03	0.71
Pressure drop	(psi)	0.079	0.043	1.49e-3
Height under nozzle	(inch)	1.3750	1.3750	64.000
Nozzle R-V-SQ	(lb/ft-sec2)	543.79	805.32	27.54
Shell ent.	(lb/ft-sec2)	184.73	3.32	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	8.98	7.72	
Pressure drop	(psi)	0.322	0.176	
Nozzle R-V-SQ	(lb/ft-sec2)	2713.9	2334.0	

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	0.4815	0.0313

Supplementary Results

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No 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	375.67 (F)
Tubesheet temperature	650.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	434.24	425.79	429.62
2	416.53	410.91	413.46
3	405.41	401.76	403.42
4	396.49	394.07	395.17

Vibration Analysis

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Position In The Bundle		**Bottom**	**Center**	**Top**
Length for natural frequency	(ft)	2.516	2.516	2.516
Length/TEMA maximum span	(--)	0.503	0.503	0.503
Number of spans	(--)	7	7	7
Tube natural frequency	(Hz)	67.3 +	71.6	77.6
Shell acoustic frequency	(Hz)			
Flow Velocities		**Bottom**	**Center**	**Top**
Window parallel velocity	(ft/sec)	0.00	0.00	0.00
Bundle crossflow velocity	(ft/sec)	0.38	0.30	5.53
Bundle/shell velocity	(ft/sec)	1.68e-5	3.01e-5	2.16e-4
Fluidelastic Instability Check		**Bottom**	**Center**	**Top**
Log decrement	HTRI	0.088	0.107	0.074
Critical velocity	(ft/sec)	7.31	10.11	21.58
Baffle tip cross velocity ratio	(--)	0.0000	0.0000	0.0000
Average crossflow velocity ratio	(--)	0.0520	0.0300	0.2564
Acoustic Vibration Check		**Bottom**	**Center**	**Top**
Vortex shedding ratio	(--)			
Chen number	(--)			
Turbulent buffeting ratio	(--)			
Tube Vibration Check		**Bottom**	**Center**	**Top**
Vortex shedding ratio	(--)	0.032	0.026	0.466
Parallel flow amplitude	(inch)	0.0000	0.0000	0.0000
Crossflow amplitude	(inch)	0.0000	0.0000	0.0005
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	1.08e-4	3.84e-5	0.0021
Crossflow RHO-V-SQ	(lb/ft-sec2)	8.61	3.06	132.70

Bundle Entrance/Exit (analysis at first tube row)		**Entrance**	**Exit**
Fluidelastic instability ratio	(--)		
Vortex shedding ratio	(--)		
Crossflow amplitude	(inch)		
Crossflow velocity	(ft/sec)		
Tubesheet to inlet/outlet support	(inch)	15.000	15.000
Shell Entrance/Exit Parameters		**Entrance**	**Exit**
Impingement device		None	--
Flow area	(ft2)	0.123	4.942
Velocity	(ft/sec)	1.76	2.83
Critical velocity	(ft/sec)		
RHO-V-SQ	(lb/ft-sec2)	184.73	3.32

Shell type	CKU	Baffle type	Support
Tube type	Plain	Baffle layout	
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)	26724
Use deresonating baffles	No	Supports/baffle space	7

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	DIESEL PRODUCT MP STEAM GENERATOR			Item No.	18-X-358 (TALLOW DIESEL MODE - EOR)
Type	CKU	Orientation	Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2	Shell/Unit	1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

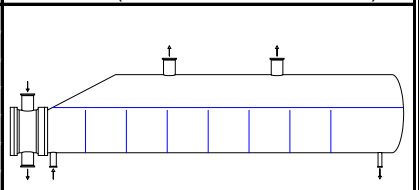
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	1000-lb/hr	46.398		345.09	
Vapor (In/Out)	wt%	0.00	90.00	0.00	0.00
Liquid	wt%	100.00	10.00	100.00	100.00
Temperature (In/Out)	F	225.00	377.41	596.00	425.00
Density	lb/ft3	59.532	0.4154 V/L 54.560	33.670	39.150
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1470	0.2921
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7740	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0500	0.0570
Critical Pressure	psia				
Inlet Pressure	psia	190.95		124.70	
Velocity	ft/sec		0.48		7.08
Pressure Drop, Allow/Calc	psi	1.500	1.290	15.000	8.946
Average Film Coefficient	Btu/ft2-hr-F	1193.5		493.97	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	42.700 MM Btu/hr	MTD (Corrected)	118.3 F	Overdesign	2.50 %
Transfer Rate, Service	121.99 Btu/ft2-hr-F	Calculated	125.04 Btu/ft2-hr-F	Clean	259.48 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design Pressure		psig	550.00	425.00
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Flow Direction			Upward	Downward
Connections Size & Rating	In	inch	1 @ 3.6240	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Liq. Out	inch	1 @ 2.4690	1 @

Tube No.	828.00	OD 0.7500 inch	Thk(Avg)	0.0913 inch	Length	18.000 ft	Pitch 1.0000 inch Tube pattern 90
Tube Type	Plain		Material	SA-179 Tube (S) K01200			Pairs seal strips 0
Shell ID	35.000 inch		Kettle ID	64.000 inch			Passlane Seal Rod No. 0
Cross Baffle Type		Support		%Cut (Diam			Impingement Plate None
Spacing(c/c)	30 inch		Inlet	inch			No. of Crosspasses 1
Rho-V2-Inlet Nozzle	543.79 lb/ft-sec2		Shell Entrance	184.73 lb/ft-sec2			Shell Exit 3.32 lb/ft-sec2
			Bundle Entrance	lb/ft-sec2			Bundle Exit lb/ft-sec2
Weight/Shell	31021 lb		Filled with Water	55689 lb			Bundle 12098 lb

Notes: Supports/baffle space = 7.

Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
Shell	10.48	Shellside	0.48	A	0.000
Tube	33.46	Tubeside	7.08	B	0.746
Fouling	51.81	Crossflow	0.44	C	0.000
Metal	4.25	Window	0.00	E	0.000
				F	0.254

HEAT EXCHANGER SPECIFICATION SHEET

Released to the following HTRI Member Company:
ST
Al Nader

US Units

Job No.	S-16030-18-X-358-TALLOWDIESELEO		
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Reference No.	PO# 4505600056
Address		Proposal No.	S21-13258-3 REV4
Plant Location	PARAMOUNT, CALIFORNIA	Date	2/6/2023 Rev D
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358 (TALLOW DIESEL MODE)
Size	35 - 64 x 216 inch Type CKU Horizontal	Connected In	1 Parallel 1 Series
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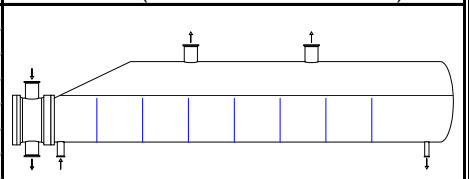
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	46398		345086	
Vapor (In/Out)			41758		
Liquid		46398	4639.8	345086	345086
Steam			41758		
Water		46398	4639.8		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	596.00	425.00
Specific Gravity		0.9540	0.8744	0.5396	0.6274
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1470	0.2921
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7740	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0500	0.0570
Latent Heat	Btu/lb	847.32	847.81		
Inlet Pressure	psia	190.95		124.70	
Velocity	ft/sec	0.48		7.08	
Pressure Drop, Allow/Calc	psi	1.500	1.290	15.000	8.946
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	42700000 Btu/hr		MTD (Corrected)	118.3	F
Transfer Rate, Service	121.99 Btu/ft2-hr-F	Clean	259.48 Btu/ft2-hr-F	Actual	125.04 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	550.00 /	425.00 /
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 3.6240	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Intermediate		@	@

Tube No. 414U OD 0.7500 inch Thk(Avg) 0.0913 inch Length 18.000 ft Pitch 1.0000 inch
Tube Type Plain Material SA-179 Tube (S) K01200 Tube pattern 90

Shell	SA-516 70 Pl. K02700 ID 35.000 OD 37.000 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	Carbon steel	Tubesheet-Floating	
Floating Head Cover		Impingement Plate	None

Baffles-Cross Type Support %Cut (Diam) Spacing(c/c) 30 Inlet 29.75 inch
Baffles-Long Seal Type None
Supports-Tube U-Bend Type None
Bypass Seal Arrangement pairs seal strips Tube-Tubesheet Joint Expanded and strength welded
Expansion Joint Type None
Rho-V2-Inlet Nozzle 543.79 lb/ft-sec2 Bundle Entrance Bundle Exit 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 31021 lb Filled with Water 55689 lb Bundle 12098 lb

Remarks: Supports/baffle space = 7.

Reprinted with Permission

Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Exchanger Data

Unit identifier	Shell 1	
Service type	Generic shell and tube	
TEMA type	CKU	
Run mode	Rating	
Hot fluid location	Tubeside	
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	Carbon steel	
Shellside gasket	Spiral Wound Metal (SS)	
Tubeside gasket	Spiral Wound Metal (SS)	
Shellside design pressure	550.00	psig
Tubeside design pressure	425.00	psig
Shellside vacuum pressure	Full	
Tubeside vacuum pressure	Full	
Shellside design temperature	550.00	F
Tubeside design temperature	650.00	F
Shellside corrosion allowance	0.1250	inch
Tubeside corrosion allowance	0.1250	inch
Tubesheet design temperature	650.00	F
Shellside radiography	Full	
Tubeside radiography	Spot	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	37.000	inch
Shell inside diameter	35.000	inch
Shell wall thickness	1.0000	inch
Front head outside diameter	37.000	inch
Front head inside diameter	35.000	inch
Front head thickness	0.625	inch
Rear head outside diameter	66.500	inch
Rear head inside diameter	64.000	inch
Rear head thickness	1.2500	inch
Total tubesheet thickness	4.6875	inch
Double tubesheet	No	
Shell expansion joint	No	
Suppress mechanical calculations	No	

Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Reboiler Data

Reboiler type	Kettle reboiler	
Kettle inside diameter	64.000	inch
Height of liquid level	37.000	inch
Height of froth	5.0000	inch
Fraction entrainment	0.0010	lb liquid/lb vapor
Reference pressure location	At top of bundle	

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	18.000	ft
Tube material	SA-179 Tube (S) K01200	

Baffle Data

Baffle type	None	
Baffle thickness	0.6250	inch
Distance from tangent to last baffle	1.4375	inch
Use deresonating baffles	No	

Supports Data

Full support at U-Bend	None	
Support plates/baffle space	7	

Nozzle Data

Shellside

Nozzle standard	01-ANSI_B36_10.TABLE			
Shell entrance type	No impingement device			
Shell exit type	Remove tubes if TEMA requires			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	4.5000	8.6250	--	inch
Nozzle inside diameter	3.6240	7.6250	--	inch
Number at this position	1	2	--	

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 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
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DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Nozzle Location Data		
Radial position on shell inlet nozzle	Bottom	
Radial position on shell outlet nozzle	Program decides	
Location of nozzle at U-bend	After U-bend	
Tubeside entry type	Radial	
Tubeside inlet position	Front head	
Tubeside exit type	Same as inlet	

Tube Layout Data		
Pass partition construction	Program set	
Force symmetric layout	Partial	
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	Calculated	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	1.5000	inch
Perpendicular/horizontal passlane width	0.7500	inch
Number of passlane seal rods	None	
Tubes to remove for tie rods	Calculated	
Number of tie rods	10	
Tie rod outside diameter	0.5000	inch
Baffle to shell clearance	0.1875	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Sensible liquid	Two phase	
Flow rate	345.09	--	1000-lb/hr
Inlet vapor fraction	0.0000	0.0000	
Outlet vapor fraction	0.0000	0.9000	
Inlet temperature	596.00	225.00	F
Outlet temperature	425.00	--	F
Inlet pressure	124.70	189.70	psia
Allowable pressure drop	15.000	1.500	psi
Exchanger duty		42.700	MM Btu/hr
Duty multiplier		1.0000	

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

Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Hot Fluid Property Data

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

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	596.00	425.00
Density, lb/ft3	33.670	39.150
Viscosity, cP	0.1470	0.2920
Thermal conductivity, Btu/hr-ft-F	0.0500	0.0570
Heat capacity, Btu/lb-F	0.7740	0.6770

Cold Fluid Property Data

Fluid name	BFW / STEAM
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	Mixed
Component quantity	1.0000

Xist 9 (32 bit) 2/6/2023 3:06 SN: 13528-113450684 **US Units**
18-X-358-1 TALLOW DIESEL MODE-EOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Control Name Data

Case name	DIESEL PRODUCT MP STEAM GENERATOR
Problem name	18-X-358-1 TALLOW DIESEL MODE-EOR
Job Number	S-16030-18-X-358-TALLOWDIESELEOR
Item Number	18-X-358 (TALLOW DIESEL
Reference Number	PO# 4505600056
Proposal Number	S21-13258-3 REV4
Revision	D
Service	DIESEL PRODUCT MP STEAM GENERATOR
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	
Use modified heat release curves for kettles	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

FABSCO SHELL & TUBE, LLC.
2410 INDUSTRIAL ROAD
SAPULPA, OK 74066
(918)224-7550 FAX(918)224-3564

Member HTRI

HEAT EXCHANGER SPECIFICATION SHEET

US Units

		Job No.	S-16030-3-18-X-358-2TALLOWDIESEL
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	P.O. No.	4505600056
Address	ALLENTOWN, PA	Fabsco Job	S21-13258-3
Plant Location	PARAMOUNT, CA	Date	02/06/2023 Rev. D
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358
Size	35 / 64 x 216 inch Type CKU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

PERFORMANCE OF ONE UNIT

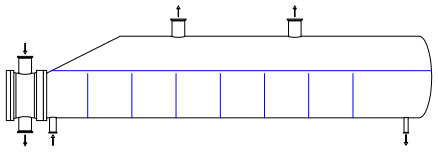
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	42899		350768	
Vapor (In/Out)			38609		
Liquid		42899	4289.9	350768	350768
Steam			38609		
Water		42899	4289.9		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	581.00	425.00
Specific Gravity		0.9540	0.8744	0.5460	0.6260
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1540	0.2900
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7660	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Latent Heat	Btu/lb	847.33	847.81		
Inlet Pressure	psig	175		110	
Velocity	ft/sec	0.46		7.15	
Pressure Drop, Allow/Calc	psi	1.500	1.261	15.000	9.088
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged 39480086 Btu/hr MTD (Corrected) 112.7 F

Transfer Rate, Service 118.38 Btu/ft2-hr-F Clean 260.15 Btu/ft2-hr-F Actual 125.32 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	550/FV / CODE	425/FV / CODE
Design Temperature		F	550 / 32	650 / 610 / 32
No Passes per Shell			KETTLE w/o WEIR	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 4"-600# RF	1 @ 8"-600# RF
	Out	inch	2 @ 8"-600# RF	1 @ 8"-600# RF
	Intermediate			

Tube No. 414 U's OD 0.7500 inch Thk(Min) 0.083 inch Length 18.000 ft Pitch 1.0000 inch

Tube Type Plain Material SA-179 Tube pattern 90

Shell	SA-516-70N (KETTLE ID = 64.00") ID 35.00 inch	Shell Cover	SA-516-70N (INTEGRAL)
Channel or Bonnet	SA-516-70	Channel Cover	SA-350-LF2 CL. 1 (REMOVABLE)
Tubesheet-Stationary	SA-350-LF2 CL. 1	Tubesheet-Floating	
Floating Head Cover		Impingement Plate	NONE

Baffles-Cross SA-516-70 Type SUPPORT %Cut (Diam) Spacing(c/c) 30.00 Inlet 29.75 inch

Baffles-Long Seal Type

Supports-Tube U-Bend Type NONE

Bypass Seal Arrangement Tube-Tubesheet Joint STRENGTH-WELD, ROLL & EXPAND (2 GROOVES)

Expansion Joint Type

Rho-V2-Inlet Nozzle 374.21 lb/ft-sec2 Bundle Entrance Bundle Exit lb/ft-sec2

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

FLAMMABLE SERVICE TUBE-SIDE. PWHT SHELL. STRESS RELIVED U-BENDS + 1' S.L.

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

Weight/Shell 36,900. lb Filled with Water 61,800. lb Bundle 12,350. lb

1. TALLOW DIESEL MODE - SOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED. 2. STEAM QUALITY IS 99.8% WHEN LIQUID LEVEL IS 12" ABOVE LLL. 3. PROVIDE (1)2"-300# RFLWN W/ BLIND IN EACH PROCESS NOZZLE.

4. SHELL-SIDE PRESSURE DROP INCLUDES LIQUID STACTIC HEADS. PRESSURE DROP SHOWN IS AT 37" LIQUID HEIGHT. AT 44" LIQUID HEIGHT, PRESSURE FROP IS 1.511 PSI. 5. PROVIDE (2)2"-300# RFLWN W/ BLIND IN CHANNEL FOR VENT & DRAIN.

6. ADDITIONAL SHELL-SIDE CONNECTIONS: (1)6"-900# RF, (2)2"-600# RFLWN, (2)2"-300# RFLWN & (11)2"-1500# RFLWN.

Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Process Conditions		Cold Shellside		Hot Tubeside	
Fluid name		BFW / STEAM		DIESEL PRODUCT	
Total flow rate	(1000-lb/hr)		42.899		350.77
Inlet/Outlet Y	(Wt. frac vap.)	0.0000	0.9000	0.0000	0.0000
Inlet/Outlet T	(Deg F)	225.00	377.41	581.00	425.00
Inlet P/Avg	(psia)	190.92	190.29	124.70	120.16
dP/Allow.	(psi)	1.261	1.500	9.088	15.000
Fouling	(ft2-hr-F/Btu)		0.00150		0.00200

Exchanger Performance

Shell h	(Btu/ft2-hr-F)	1167.2	Actual U	(Btu/ft2-hr-F)	125.32
Tube h	(Btu/ft2-hr-F)	496.87	Required U	(Btu/ft2-hr-F)	118.38
Hot regime	(--)	Sens. Liquid	Total duty	(MM Btu/hr)	39.480
Cold regime	(--)	Flow	Eff. area	(ft2)	2958.9
EMTD	(Deg F)	112.7	Overdesign	(%)	5.86

Shell Geometry			Baffle Geometry		
TEMA type	(--)	CKU	Baffle type		Support
Shell ID	(inch)	35.000	Baffle cut	(Pct Dia.)	
Series	(--)	1	Baffle orientation	(--)	
Parallel	(--)	1	Central spacing	(inch)	30
Orientation	(deg)	0.00	Crosspasses	(--)	1

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	3.8260
Tube OD	(inch)	0.7500	Shell outlet	(inch)	7.6250
Length	(ft)	18.000	Inlet height	(inch)	1.3750
Pitch ratio	(--)	1.3333	Outlet height	(inch)	1.3750
Layout	(deg)	90	Tube inlet	(inch)	7.6250
Tubecount	(--)	828	Tube outlet	(inch)	7.6250
Tube Pass	(--)	4			

Thermal Resistance, %		Velocities, ft/sec	Min	Max	Flow Fractions	
Shell	10.74				A	0.000
Tube	33.24	Tubeside	6.83	7.77	B	0.745
Fouling	51.83	Crossflow	0.16	2.24	C	0.000
Metal	4.19	Longitudinal	--	--	E	0.000
					F	0.255

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DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Geometry, Mechanical Design, and Vibration

The bundle entrance and exit vibration analysis is not available for TEMA K shells. The entrance and exit areas cannot be accurately defined with information available in the program, and the nozzle flow rates often do not accurately represent the flow across the bundle due to fluid circulation. (MN 0018)

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)

Total tubesheet thickness specified is less than sum of the calculated tubesheet thicknesses. (MN 10033)

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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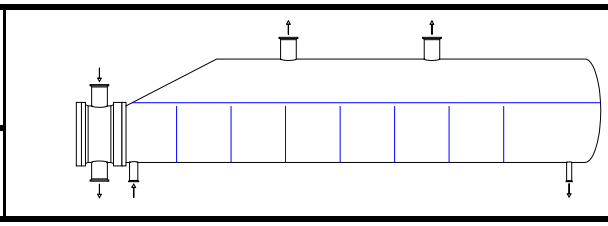
Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Process Data		Cold Shellside		Hot Tubeside	
Fluid name			BFW / STEAM		DIESEL PRODUCT
Fluid condition			Boil. Liquid		Sens. Liquid
Total flow rate	(1000-lb/hr)		42.899		350.77
Weight fraction vapor, In/Out	(--)	0.0000	0.9000	0.0000	0.0000
Temperature, In/Out	(Deg F)	225.00	377.41	581.00	425.00
Skin temperature, Min/Max	(Deg F)	379.08	390.42	407.68	510.24
Wall temperature, Min/Max	(Deg F)	388.68	430.63	390.82	439.59
Pressure, In/Average	(psia)	190.92	190.29	124.70	120.16
Pressure drop, Total/Allowed	(psi)	1.261	1.500	9.088	15.000
Velocity, Mid/Max allow	(ft/sec)	0.46		7.15	
Boiling range	(Deg F)		0.0		
Average film coef.	(Btu/ft2-hr-F)		1167.2		496.87
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)	118.38 /	260.15 /	125.32	
Heat duty, Calculated/Specified	(MM Btu/hr)	39.480 /			
Effective overall temperature difference	(Deg F)	112.7			
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	112.7 *	1.0000 *	1.0000	

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	355.67
Approximate tubeside	(ft3)	41.253

Shell Construction Information

TEMA shell type		CKU		Shell ID	(inch)	35.000
Shells Series	1	Parallel	1	Total area	(ft2)	3081.7
Passes Shell	1	Tube	4	Eff. area	(ft2/shell)	2958.9
Shell orientation angle (deg)		0.00		Kettle ID	(inch)	64.000
Impingement present		No				
Pairs seal strips		0		Passlane seal rods (inch)	0.7500	No. 0
Shell expansion joint		No		Full support at U-Bend		No
Weight estimation Wet/Dry/Bundle			57105 / 32328 / 11928		(lb/shell)	

Baffle Information

Type		Support	Baffle cut (% dia)		
Crosspasses/shellpass		1	No. (Pct Area)	(inch) to C.L	
Central spacing	(inch)	30	1		
Inlet spacing	(inch)	0.0000	2		
Outlet spacing	(inch)	0.0000	Support plates/baffle space		7
Baffle thickness	(inch)	0.6250			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		828
Length to tangent	(ft)	18.000	Pct tubes removed (both)		2.01
Effective length	(ft)	18.200	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	4.6875	Wall thickness	(inch)	0.0905
Area ratio	(out/in)	1.3180	Pitch (inch) 1.0000	Ratio	1.3333
Tube metal		SA-179 Tube (S) K01200	Tube pattern (deg)		90

Final Results

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Al Nader

Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Shellside Performance

Nom vel, X-flow/window	0.42 / 0.00
Kettle Recirculation Ratio (Internal/Feed)	10.13

Flow fractions for vapor phase
A=0.0000 B=0.7454 C=5.63e-6 E=0.0000 F=0.2546

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
1.050	1.000	1.050	1.000	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
92.65	0.00	0.00	Inlet	4.40	3.62
MOMENTUM		0.00	Outlet	2.95	2.01

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
PP/TBR	Subcool	Flow	Flow	

H. T. Parameters		Shell	Tube
Overall wall correction			0.985
Midpoint	Prandtl no.		7.06
Midpoint	Reynolds no.	6940	83284
Bundle inlet	Reynolds no.	6489	119204
Bundle outlet	Reynolds no.	7147	65389
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
10.74	33.24	51.83	4.19	5.86

Total fouling resistance	(ft2-hr-F/Btu)	0.0041
Differential resistance	(ft2-hr-F/Btu)	4.67e-4

Shell Nozzles

Inlet at channel end		Yes		
Nozzle location at U-bend		After U-bend		
		Inlet	**Outlet**	**Liquid Outlet**
Number at each position		1	2	1
Diameter	(inch)	3.8260	7.6250	2.4690
Velocity	(ft/sec)	2.51	40.71	0.66
Pressure drop	(psi)	0.055	0.037	1.27e-3
Height under nozzle	(inch)	1.3750	1.3750	64.000
Nozzle R-V-SQ	(lb/ft-sec2)	374.21	688.45	23.54
Shell ent.	(lb/ft-sec2)	140.38	2.83	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	9.02	7.87	
Pressure drop	(psi)	0.329	0.183	
Nozzle R-V-SQ	(lb/ft-sec2)	2771.1	2417.1	

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

Diametral Clearances (inch)

Baffle-to-shell	Bundle-to-shell	Tube-to-baffle
0.1875	0.4815	0.0313

Supplementary Results

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No 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	375.72 (F)
Tubesheet temperature	650.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	431.09	423.30	426.84
2	414.98	409.70	412.10
3	404.83	401.34	402.92
4	396.45	394.10	395.17

Vibration Analysis

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Position In The Bundle		**Bottom**	**Center**	**Top**
Length for natural frequency	(ft)	2.516	2.516	2.516
Length/TEMA maximum span	(--)	0.503	0.503	0.503
Number of spans	(--)	7	7	7
Tube natural frequency	(Hz)	67.3 +	72.1	77.7
Shell acoustic frequency	(Hz)			
Flow Velocities		**Bottom**	**Center**	**Top**
Window parallel velocity	(ft/sec)	0.00	0.00	0.00
Bundle crossflow velocity	(ft/sec)	0.35	0.30	5.12
Bundle/shell velocity	(ft/sec)	1.56e-5	2.99e-5	2.01e-4
Fluidelastic Instability Check		**Bottom**	**Center**	**Top**
Log decrement	HTRI	0.088	0.107	0.075
Critical velocity	(ft/sec)	7.36	10.45	21.69
Baffle tip cross velocity ratio	(--)	0.0000	0.0000	0.0000
Average crossflow velocity ratio	(--)	0.0478	0.0287	0.2359
Acoustic Vibration Check		**Bottom**	**Center**	**Top**
Vortex shedding ratio	(--)			
Chen number	(--)			
Turbulent buffeting ratio	(--)			
Tube Vibration Check		**Bottom**	**Center**	**Top**
Vortex shedding ratio	(--)	0.030	0.025	0.430
Parallel flow amplitude	(inch)	0.0000	0.0000	0.0000
Crossflow amplitude	(inch)	0.0000	0.0000	0.0004
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	9.25e-5	3.51e-5	0.0017
Crossflow RHO-V-SQ	(lb/ft-sec2)	7.36	2.79	113.51

Bundle Entrance/Exit (analysis at first tube row)		**Entrance**	**Exit**
Fluidelastic instability ratio	(--)		
Vortex shedding ratio	(--)		
Crossflow amplitude	(inch)		
Crossflow velocity	(ft/sec)		
Tubesheet to inlet/outlet support	(inch)	15.000	15.000
Shell Entrance/Exit Parameters		**Entrance**	**Exit**
Impingement device		None	--
Flow area	(ft2)	0.130	4.942
Velocity	(ft/sec)	1.54	2.61
Critical velocity	(ft/sec)		
RHO-V-SQ	(lb/ft-sec2)	140.38	2.83

Shell type	CKU	Baffle type	Support
Tube type	Plain	Baffle layout	
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)	26814
Use deresonating baffles	No	Supports/baffle space	7

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:
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US Units

Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358 (TALLOW DIESEL MODE - SOR)
Type	CKU	Orientation	Horizontal
Connected In	1 Parallel 1 Series		
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2	Shell/Unit	1
Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2		

PERFORMANCE OF ONE UNIT

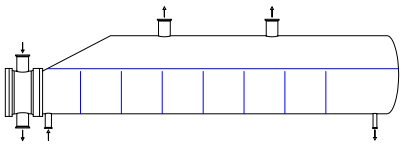
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	1000-lb/hr	42.899		350.77	
Vapor (In/Out)	wt%	0.00	90.00	0.00	0.00
Liquid	wt%	100.00	10.00	100.00	100.00
Temperature (In/Out)	F	225.00	377.41	581.00	425.00
Density	lb/ft3	59.532	0.4154 V/L 54.560	34.070	39.060
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1540	0.2900
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7660	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Critical Pressure	psia				
Inlet Pressure	psia	190.92		124.70	
Velocity	ft/sec		0.46		7.15
Pressure Drop, Allow/Calc	psi	1.500	1.261	15.000	9.088
Average Film Coefficient	Btu/ft2-hr-F	1167.2		496.87	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	39.480 MM Btu/hr	MTD (Corrected)	112.7 F	Overdesign	5.86 %
Transfer Rate, Service	118.38 Btu/ft2-hr-F	Calculated	125.32 Btu/ft2-hr-F	Clean	260.15 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design Pressure		psig	550.00	425.00
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Flow Direction			Upward	Downward
Connections Size & Rating	In	inch	1 @ 3.8260	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Liq. Out	inch	1 @ 2.4690	1 @



Tube No.	828.00	OD 0.7500 inch	Thk(Avg) 0.0905 inch	Length 18.000 ft	Pitch 1.0000 inch	Tube pattern	90
Tube Type	Plain		Material SA-179 Tube (S) K01200		Pairs seal strips	0	
Shell ID	35.000 inch		Kettle ID 64.000 inch		Passlane Seal Rod No.	0	
Cross Baffle Type		Support	%Cut (Diam		Impingement Plate	None	
Spacing(c/c)	30.188 inch		Inlet inch		No. of Crosspasses	1	
Rho-V2-Inlet Nozzle	374.21 lb/ft-sec2		Shell Entrance 140.38 lb/ft-sec2		Shell Exit 2.83 lb/ft-sec2		
			Bundle Entrance lb/ft-sec2		Bundle Exit lb/ft-sec2		
Weight/Shell	32328 lb		Filled with Water 57105 lb		Bundle 11928 lb		

Notes: Supports/baffle space = 7.

Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
Shell	10.74	Shellside	0.46	A	0.000
Tube	33.24	Tubeside	7.15	B	0.745
Fouling	51.83	Crossflow	0.42	C	0.000
Metal	4.19	Window	0.00	E	0.000
				F	0.255

HEAT EXCHANGER SPECIFICATION SHEET

Released to the following HTRI Member Company:
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US Units

Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Job No.	S-16030-3-18-X-358-2
Address		Reference No.	P.O. # 4505600056
Plant Location	PARAMOUNT, CALIFORNIA	Proposal No.	S21-13258-3 REV3
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Date	2/6/2023 Rev D
Size	35 - 64 x 216 inch Type CKU Horizontal	Item No.	18-X-358 (TALLOW DIESEL MODE-S
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2 Shell/Unit 1	Connected In	1 Parallel 1 Series
		Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

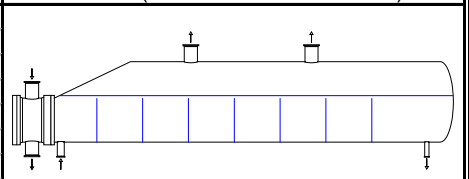
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	42899		350768	
Vapor (In/Out)			38609		
Liquid		42899	4289.9	350768	350768
Steam			38609		
Water		42899	4289.9		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	581.00	425.00
Specific Gravity		0.9540	0.8744	0.5460	0.6260
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1540	0.2900
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7660	0.6770
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Latent Heat	Btu/lb	847.33	847.81		
Inlet Pressure	psia	190.92		124.70	
Velocity	ft/sec	0.46		7.15	
Pressure Drop, Allow/Calc	psi	1.500	1.261	15.000	9.088
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	39480086 Btu/hr		MTD (Corrected)	112.7	F
Transfer Rate, Service	118.38 Btu/ft2-hr-F	Clean 260.15 Btu/ft2-hr-F	Actual	125.32	Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	550.00 /	425.00 /
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 3.8260	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Intermediate		@	@

Tube No. 414U OD 0.7500 inch Thk(Avg) 0.0905 inch Length 18.000 ft Pitch 1.0000 inch
Tube Type Plain Material SA-179 Tube (S) K01200 Tube pattern 90

Shell	SA-516 70 Pl. K02700 ID 35.000 OD 37.000 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	None

Baffles-Cross Type Support %Cut (Diam) Spacing(c/c) 30 Inlet inch
Baffles-Long Seal Type None
Supports-Tube U-Bend Type None
Bypass Seal Arrangement pairs seal strips Tube-Tubesheet Joint Expanded and strength welded
Expansion Joint Type None
Rho-V2-Inlet Nozzle 374.21 lb/ft-sec2 Bundle Entrance Bundle Exit lb/ft-sec2

Gaskets-Shell Side 304 S.S. SPIRAL WOUND Tube Side 304 S.S. SPIRAL WOUND
- Floating Head
Code Requirements TEMA Class R
Weight/Shell 32328 lb Filled with Water 57105 lb Bundle 11928 lb

Remarks: Supports/baffle space = 7.

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Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Exchanger Data

Unit identifier	Shell 1	
Service type	Generic shell and tube	
TEMA type	CKU	
Run mode	Rating	
Hot fluid location	Tubeside	
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	
Shellside gasket	304 S.S. SPIRAL WOUND	
Tubeside gasket	304 S.S. SPIRAL WOUND	
Shellside design pressure	550.00	psig
Tubeside design pressure	425.00	psig
Shellside vacuum pressure	Full	
Tubeside vacuum pressure	Full	
Shellside design temperature	550.00	F
Tubeside design temperature	650.00	F
Shellside corrosion allowance	0.1250	inch
Tubeside corrosion allowance	0.1250	inch
Tubesheet design temperature	650.00	F
Shellside radiography	Full	
Tubeside radiography	Spot	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	37.000	inch
Shell inside diameter	35.000	inch
Shell wall thickness	1.0000	inch
Front head outside diameter	36.75	inch
Front head inside diameter	35.5	inch
Front head thickness	0.625	inch
Rear head outside diameter	66.500	inch
Rear head inside diameter	64.000	inch
Rear head thickness	1.2500	inch
Total tubesheet thickness	4.6875	inch
Double tubesheet	No	
Shell expansion joint	No	
Suppress mechanical calculations	No	

Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Reboiler Data

Reboiler type	Kettle reboiler	
Kettle inside diameter	64.000	inch
Height of liquid level	37.000	inch
Height of froth	5.0000	inch
Fraction entrainment	0.0010	lb liquid/lb vapor
Reference pressure location	At top of bundle	

Tube Data

Tube type	Plain	
Tube outside diameter	0.7500	inch
Tube wall thickness	0.0905	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	18.000	ft
Tube material	SA-179 Tube (S) K01200	

Baffle Data

Baffle type	None	
Baffle thickness	0.6250	inch
Distance from tangent to last baffle	1.4375	inch
Use deresonating baffles	No	

Supports Data

Full support at U-Bend	None	
Support plates/baffle space	7	

Nozzle Data

Shellside

Nozzle standard	01-ANSI_B36_10.TABLE			
Shell entrance type	No impingement device			
Shell exit type	Remove tubes if TEMA requires			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	4.5760	8.6250	--	inch
Nozzle inside diameter	3.8260	7.6250	--	inch
Number at this position	1	2	--	

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	--	

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Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Nozzle Location Data		
Radial position on shell inlet nozzle	Program decides	
Radial position on shell outlet nozzle	Program decides	
Location of nozzle at U-bend	After U-bend	
Tubeside entry type	Radial	
Tubeside inlet position	Front head	
Tubeside exit type	Same as inlet	

Tube Layout Data		
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	Calculated	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	1.5000	inch
Perpendicular/horizontal passlane width	0.7500	inch
Number of passlane seal rods	None	
Tubes to remove for tie rods	None	
Number of tie rods	20	
Tie rod outside diameter	0.5000	inch
Baffle to shell clearance	0.1875	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Sensible liquid	Two phase	
Flow rate	350.77	--	1000-lb/hr
Inlet vapor fraction	0.0000	0.0000	
Outlet vapor fraction	0.0000	0.9000	
Inlet temperature	581.00	225.00	F
Outlet temperature	425.00	--	F
Inlet pressure	124.70	189.70	psia
Allowable pressure drop	15.000	1.500	psi
Duty multiplier		1.0000	

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

Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Hot Fluid Property Data

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

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	581.00	425.00
Density, lb/ft3	34.070	39.060
Viscosity, cP	0.1540	0.2900
Thermal conductivity, Btu/hr-ft-F	0.0510	0.0570
Heat capacity, Btu/lb-F	0.7660	0.6770

Cold Fluid Property Data

Fluid name	BFW / STEAM
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	Mixed
Component quantity	1.0000

Xist 9 (32 bit) 2/6/2023 3:40 SN: 13528-113450684 **US Units**
18-X-358-2 TALLOW DIESEL MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Control Name Data

Case name	DIESEL PRODUCT MP STEAM GENERATOR
Problem name	18-X-358-2 TALLOW DIESEL MODE - SOR
Job Number	S-16030-3-18-X-358-2
Item Number	18-X-358 (TALLOW DIESEL MODE - SOR)
Reference Number	P.O. # 4505600056
Proposal Number	S-16030
Revision	D
Service	DIESEL PRODUCT MP STEAM GENERATOR
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	
Use modified heat release curves for kettles	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

FABSCO SHELL & TUBE, LLC.
2410 INDUSTRIAL ROAD
SAPULPA, OK 74066
(918)224-7550 FAX(918)224-3564

Member HTRI

HEAT EXCHANGER SPECIFICATION SHEET

US Units

		Job No.	S-16030-3-18-X-358-2CORNOILJETSC
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	P.O. No.	4505600056
Address	ALLENTOWN, PA	Fabsco Job	S21-13258-3
Plant Location	PARAMOUNT, CA	Date	02/06/2023 Rev. D
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358
Size	35 / 64 x 216 inch Type CKU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

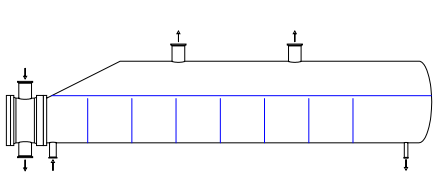
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	27817		271041	
Vapor (In/Out)			25035		
Liquid		27817	2781.7	271041	271041
Steam			25035		
Water		27817	2781.7		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	556.00	425.00
Specific Gravity		0.9540	0.8744	0.5513	0.6191
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1590	0.2700
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7600	0.6840
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Latent Heat	Btu/lb	847.34	847.81		
Inlet Pressure	psig	175		110	
Velocity	ft/sec	0.35		5.59	
Pressure Drop, Allow/Calc	psi	1.500	1.207	15.000	5.842
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	25600000 Btu/hr			MTD (Corrected)	103.2 F
Transfer Rate, Service	83.85 Btu/ft2-hr-F	Clean	222.71 Btu/ft2-hr-F	Actual	115.82 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	/	/
Design Temperature		F		
No Passes per Shell				
Corrosion Allowance		inch		
Connections Size & Rating	In	inch		
	Out	inch		
	Intermediate			

Tube No.	OD	inch	Thk(Min)	inch	Length	ft	Pitch	inch	
Tube Type			Material				Tube pattern		
Shell			ID	inch	Shell Cover				
Channel or Bonnet					Channel Cover				
Tubesheet-Stationary					Tubesheet-Floating				
Floating Head Cover					Impingement Plate				
Baffles-Cross		Type		%Cut (Diam)		Spacing(c/c)		Inlet	inch
Baffles-Long				Seal Type					
Supports-Tube				U-Bend				Type	
Bypass Seal Arrangement				Tube-Tubesheet Joint					
Expansion Joint				Type					
Rho-V2-Inlet Nozzle	157.34	lb/ft-sec2		Bundle Entrance		Bundle Exit		lb/ft-sec2	

Gaskets -

Code Requirements				TEMA Class	
Weight/Shell	lb	Filled with Water	lb	Bundle	lb

1. CORN OIL JET MODE - SOR. UNIT IS THERMALLY & MECHANICALLY GUARANTEED.

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Output Summary

Released to the following HTRI Member Company:
ST
Al Nader

Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Process Conditions		Cold Shellside		Hot Tubeside	
Fluid name		BFW / STEAM		DIESEL PRODUCT	
Total flow rate	(1000-lb/hr)		27.817		271.04
Inlet/Outlet Y	(Wt. frac vap.)	0.0000	0.9000	0.0000	0.0000
Inlet/Outlet T	(Deg F)	225.00	377.41	556.00	425.00
Inlet P/Avg	(psia)	190.89	190.29	124.70	121.78
dP/Allow.	(psi)	1.207	1.500	5.842	15.000
Fouling	(ft2-hr-F/Btu)		0.00150		0.00200

Exchanger Performance					
Shell h	(Btu/ft2-hr-F)	1054.2	Actual U	(Btu/ft2-hr-F)	115.82
Tube h	(Btu/ft2-hr-F)	412.21	Required U	(Btu/ft2-hr-F)	83.85
Hot regime	(--)	Sens. Liquid	Total duty	(MM Btu/hr)	25.600
Cold regime	(--)	Flow	Eff. area	(ft2)	2958.9
EMTD	(Deg F)	103.2	Overdesign	(%)	38.13

Shell Geometry			Baffle Geometry		
TEMA type	(--)	CKU	Baffle type		Support
Shell ID	(inch)	35.000	Baffle cut	(Pct Dia.)	
Series	(--)	1	Baffle orientation	(--)	
Parallel	(--)	1	Central spacing	(inch)	30
Orientation	(deg)	0.00	Crosspasses	(--)	1

Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(inch)	3.8260
Tube OD	(inch)	0.7500	Shell outlet	(inch)	7.6250
Length	(ft)	18.000	Inlet height	(inch)	1.3750
Pitch ratio	(--)	1.3333	Outlet height	(inch)	1.3750
Layout	(deg)	90	Tube inlet	(inch)	7.6250
Tubecount	(--)	828	Tube outlet	(inch)	7.6250
Tube Pass	(--)	4			

Thermal Resistance, %		Velocities, ft/sec	Min	Max	Flow Fractions	
Shell	10.99				A	0.000
Tube	37.14	Tubeside	5.37	5.99	B	0.745
Fouling	47.99	Crossflow	0.14	1.44	C	0.000
Metal	3.88	Longitudinal	--	--	E	0.000
					F	0.255

Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Unit ID 100 - WARNING MESSAGES (CALCULATIONS CONTINUE)

Geometry, Mechanical Design, and Vibration

The bundle entrance and exit vibration analysis is not available for TEMA K shells. The entrance and exit areas cannot be accurately defined with information available in the program, and the nozzle flow rates often do not accurately represent the flow across the bundle due to fluid circulation. (MN 0018)

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)

Total tubesheet thickness specified is less than sum of the calculated tubesheet thicknesses. (MN 10033)

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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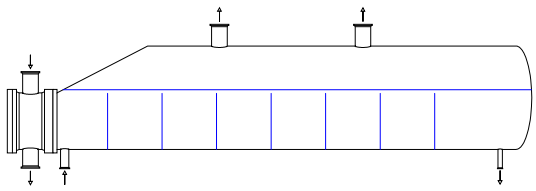
Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Process Data		Cold Shellside		Hot Tubeside	
Fluid name			BFW / STEAM		DIESEL PRODUCT
Fluid condition			Boil. Liquid		Sens. Liquid
Total flow rate	(1000-lb/hr)		27.817		271.04
Weight fraction vapor, In/Out	(--)	0.0000	0.9000	0.0000	0.0000
Temperature, In/Out	(Deg F)	225.00	377.41	556.00	425.00
Skin temperature, Min/Max	(Deg F)	381.30	390.51	406.87	486.88
Wall temperature, Min/Max	(Deg F)	389.86	422.79	391.77	429.99
Pressure, In/Average	(psia)	190.89	190.29	124.70	121.78
Pressure drop, Total/Allowed	(psi)	1.207	1.500	5.842	15.000
Velocity, Mid/Max allow	(ft/sec)	0.35		5.59	
Boiling range	(Deg F)		0.0		
Average film coef.	(Btu/ft2-hr-F)		1054.2		412.21
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)	83.85	/ 222.71	/	115.82
Heat duty, Calculated/Specified	(MM Btu/hr)	25.600	/ 25.600		
Effective overall temperature difference	(Deg F)	103.2			
EMTD = (MTD) * (DELTA) * (F/G/H)	(Deg F)	103.2	* 1.0000	*	1.0000

See Runtime Messages Report for warnings.



Exchanger Fluid Volumes

Approximate shellside	(ft3)	355.67
Approximate tubeside	(ft3)	41.086

Shell Construction Information

TEMA shell type	CKU		Shell ID	(inch)	35.000
Shells Series	1 Parallel	1	Total area	(ft2)	3081.7
Passes Shell	1 Tube	4	Eff. area	(ft2/shell)	2958.9
Shell orientation angle (deg)	0.00		Kettle ID	(inch)	64.000
Impingement present	No				
Pairs seal strips	0		Passlane seal rods (inch)	0	No. 0
Shell expansion joint	No		Full support at U-Bend		No
Weight estimation Wet/Dry/Bundle		57177 / 32410 / 12010			(lb/shell)

Baffle Information

Type		Support	Baffle cut (% dia)		
Crosspasses/shellpass		1	No. (Pct Area)	(inch) to C.L	
Central spacing	(inch)	30	1		
Inlet spacing	(inch)	29.75	2		
Outlet spacing	(inch)	0.0000	Support plates/baffle space		7
Baffle thickness	(inch)	0.6250			
Use deresonating baffles		No			

Tube Information

Tube type		Plain	Tubecount per shell		828
Length to tangent	(ft)	18.000	Pct tubes removed (both)		2.01
Effective length	(ft)	18.200	Outside diameter	(inch)	0.7500
Total tubesheet	(inch)	4.6875	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

Final Results

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Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Shellside Performance

Nom vel, X-flow/window 0.32 / 0.00
Kettle Recirculation Ratio (Internal/Feed) 13.06
Flow fractions for vapor phase
A=0.0000 B=0.7447 C=5.70e-6 E=0.0000 F=0.2553

Shellside Heat Transfer Corrections

Total	Beta	Gamma	End	Fin
1.050	1.000	1.050	1.000	1.000

Pressure Drops (Percent of Total)

Cross	Window	Ends	Nozzle	Shell	Tube
96.76	0.00	0.00	Inlet	1.95	3.33
MOMENTUM		0.00	Outlet	1.29	1.89

Two-Phase Parameters

Method	Inlet	Center	Outlet	Mix F
PP/TBR	Subcool	Flow	Flow	

H. T. Parameters		Shell	Tube
Overall wall correction			0.985
Midpoint	Prandtl no.		6.85
Midpoint	Reynolds no.	5794	66950
Bundle inlet	Reynolds no.	5486	89881
Bundle outlet	Reynolds no.	5902	54375
Fouling layer	(inch)		

Thermal Resistance, %

Shell	Tube	Fouling	Metal	Over Des
10.99	37.14	47.99	3.88	38.13

Total fouling resistance (ft2-hr-F/Btu) 0.0041
Differential resistance (ft2-hr-F/Btu) 0.0033

Shell Nozzles

Inlet at channel end Yes
Nozzle location at U-bend After U-bend

		Inlet	Outlet	Liquid Outlet
Number at each position		1	2	1
Diameter	(inch)	3.8260	7.6250	2.0670
Velocity	(ft/sec)	1.63	26.40	0.61
Pressure drop	(psi)	0.024	0.016	1.09e-3
Height under nozzle	(inch)	1.3750	1.3750	64.000
Nozzle R-V-SQ	(lb/ft-sec2)	157.34	289.46	20.15
Shell ent.	(lb/ft-sec2)	59.02	1.19	

Tube Nozzle		Inlet	Outlet	Liquid Outlet
		RADIAL	RADIAL	
Diameter	(inch)	7.6250	7.6250	
Velocity	(ft/sec)	6.90	6.15	
Pressure drop	(psi)	0.195	0.110	
Nozzle R-V-SQ	(lb/ft-sec2)	1638.7	1459.2	

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	0.4815	0.0313

Supplementary Results

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No 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	376.24 (F)
Tubesheet temperature	650.00 (F)

Mean tube metal temperature in each tubepass, (F)

Tube Pass	Inside	Outside	Radial
1	423.28	416.93	419.82
2	410.65	406.17	408.20
3	402.64	399.59	400.97
4	395.77	393.64	394.60

Vibration Analysis

Released to the following HTRI Member Company:
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Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

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

Position In The Bundle		Bottom	Center	Top
Length for natural frequency	(ft)	2.516	2.516	2.516
Length/TEMA maximum span	(--)	0.503	0.503	0.503
Number of spans	(--)	7	7	7
Tube natural frequency	(Hz)	67.5 +	72.4	77.6
Shell acoustic frequency	(Hz)			

Flow Velocities		Bottom	Center	Top
Window parallel velocity	(ft/sec)	0.00	0.00	0.00
Bundle crossflow velocity	(ft/sec)	0.29	0.25	3.40
Bundle/shell velocity	(ft/sec)	1.32e-5	2.57e-5	1.35e-4

Fluidelastic Instability Check		Bottom	Center	Top
Log decrement	HTRI	0.088	0.122	0.084
Critical velocity	(ft/sec)	7.38	11.31	20.72
Baffle tip cross velocity ratio	(--)	0.0000	0.0000	0.0000
Average crossflow velocity ratio	(--)	0.0399	0.0224	0.1639

Acoustic Vibration Check		Bottom	Center	Top
Vortex shedding ratio	(--)			
Chen number	(--)			
Turbulent buffeting ratio	(--)			

Tube Vibration Check		Bottom	Center	Top
Vortex shedding ratio	(--)	0.025	0.021	0.285
Parallel flow amplitude	(inch)	0.0000	0.0000	0.0000
Crossflow amplitude	(inch)	0.0000	0.0000	0.0002
Tube gap	(inch)	0.2500	0.2500	0.2500
Crossflow amplitude/tube gap	(--)	6.40e-5	2.46e-5	8.42e-4
Crossflow RHO-V-SQ	(lb/ft-sec2)	5.15	1.98	63.03

Bundle Entrance/Exit (analysis at first tube row)		Entrance	Exit
Fluidelastic instability ratio	(--)		
Vortex shedding ratio	(--)		
Crossflow amplitude	(inch)		
Crossflow velocity	(ft/sec)		
Tubesheet to inlet/outlet support	(inch)	15.000	15.000

Shell Entrance/Exit Parameters		Entrance	Exit
Impingement device		None	--
Flow area	(ft2)	0.130	4.942
Velocity	(ft/sec)	1.00	1.69
Critical velocity	(ft/sec)		
RHO-V-SQ	(lb/ft-sec2)	59.02	1.19

Shell type	CKU	Baffle type	Support
Tube type	Plain	Baffle layout	
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)	26964
Use deresonating baffles	No	Supports/baffle space	7

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:
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US Units

Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR			Item No.	18-X-358 (CORNOIL JET-SOR)
Type	CKU	Orientation	Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2	Shell/Unit	1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

PERFORMANCE OF ONE UNIT

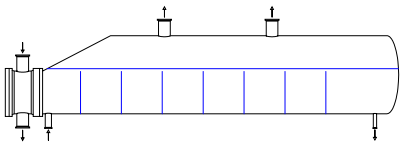
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	1000-lb/hr	27.817		271.04	
Vapor (In/Out)	wt%	0.00	90.00	0.00	0.00
Liquid	wt%	100.00	10.00	100.00	100.00
Temperature (In/Out)	F	225.00	377.41	556.00	425.00
Density	lb/ft3	59.532	0.4154 V/L 54.560	34.400	38.630
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1590	0.2700
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7600	0.6840
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Critical Pressure	psia				
Inlet Pressure	psia	190.89		124.70	
Velocity	ft/sec		0.35		5.59
Pressure Drop, Allow/Calc	psi	1.500	1.207	15.000	5.842
Average Film Coefficient	Btu/ft2-hr-F	1054.2		412.21	
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged	25.600 MM Btu/hr	MTD (Corrected)	103.2 F	Overdesign	38.13 %
Transfer Rate, Service	83.85 Btu/ft2-hr-F	Calculated	115.82 Btu/ft2-hr-F	Clean	222.71 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

			Shell Side	Tube Side
Design Pressure		psig	550.00	425.00
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Flow Direction			Upward	Downward
Connections Size & Rating	In	inch	1 @ 3.8260	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Liq. Out	inch	1 @ 2.0670	1 @



Tube No.	828.00	OD 0.7500 inch	Thk(Avg) 0.0913 inch	Length 18.000 ft	Pitch 1.0000 inch	Tube pattern	90
Tube Type	Plain		Material SA-179 Tube (S) K01200		Pairs seal strips	0	
Shell ID	35.000 inch		Kettle ID 64.000 inch		Passlane Seal Rod No.	0	
Cross Baffle Type		Support	%Cut (Diam		Impingement Plate	None	
Spacing(c/c)	30 inch		Inlet inch		No. of Crosspasses	1	
Rho-V2-Inlet Nozzle	157.34 lb/ft-sec2		Shell Entrance 59.02 lb/ft-sec2		Shell Exit 1.19 lb/ft-sec2		
			Bundle Entrance lb/ft-sec2		Bundle Exit lb/ft-sec2		
Weight/Shell	32410 lb		Filled with Water 57177 lb		Bundle 12010 lb		

Notes: Supports/baffle space = 7.

Thermal Resistance, %		Velocities, ft/sec		Flow Fractions	
Shell	10.99	Shellside	0.35	A	0.000
Tube	37.14	Tubeside	5.59	B	0.745
Fouling	47.99	Crossflow	0.32	C	0.000
Metal	3.88	Window	0.00	E	0.000
				F	0.255

HEAT EXCHANGER SPECIFICATION SHEET

Released to the following HTRI Member Company:
ST
Al Nader

US Units

Job No.	S-16030-3-18-X-358-2CORNOILJETSO		
Customer	AIR PRODUCTS (WORLD ENERGY PARAMOUNT)	Reference No.	P.O # 4505600056
Address		Proposal No.	S21-13258-3 REV3
Plant Location	PARAMOUNT, CALIFORNIA	Date	2/6/2023 Rev D
Service of Unit	DIESEL PRODUCT MP STEAM GENERATOR	Item No.	18-X-358 (CORNOIL JET-SOR)
Size	35 - 64 x 216 inch Type CKU Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	3081.7 / 2958.9 ft2 Shell/Unit 1	Surf/Shell (Gross/Eff)	3081.7 / 2958.9 ft2

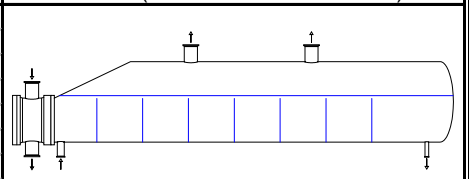
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		BFW / STEAM		DIESEL PRODUCT	
Fluid Quantity, Total	lb/hr	27817		271041	
Vapor (In/Out)			25035		
Liquid		27817	2781.7	271041	271041
Steam			25035		
Water		27817	2781.7		
Noncondensables					
Temperature (In/Out)	F	225.00	377.41	556.00	425.00
Specific Gravity		0.9540	0.8744	0.5513	0.6191
Viscosity	cP	0.2620	0.0154 V/L 0.1403	0.1590	0.2700
Molecular Weight		18.02	18.02 V/L 18.02		
Molecular Weight, Noncondensables					
Specific Heat	Btu/lb-F	1.0094	0.6865 V/L 1.0648	0.7600	0.6840
Thermal Conductivity	Btu/hr-ft-F	0.3936	0.0217 V/L 0.3862	0.0510	0.0570
Latent Heat	Btu/lb	847.34	847.81		
Inlet Pressure	psia	190.89		124.70	
Velocity	ft/sec	0.35		5.59	
Pressure Drop, Allow/Calc	psi	1.500	1.207	15.000	5.842
Fouling Resistance (min)	ft2-hr-F/Btu	0.00150		0.00200	

Heat Exchanged 25600000 Btu/hr MTD (Corrected) 103.2 F
Transfer Rate, Service 83.85 Btu/ft2-hr-F Clean 222.71 Btu/ft2-hr-F Actual 115.82 Btu/ft2-hr-F

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		psig	550.00 /	425.00 /
Design Temperature		F	550.00	650.00
No Passes per Shell			1	4
Corrosion Allowance		inch	0.1250	0.1250
Connections Size & Rating	In	inch	1 @ 3.8260	1 @ 7.6250
	Out	inch	2 @ 7.6250	1 @ 7.6250
	Intermediate		@	@

Tube No. 414U OD 0.7500 inch Thk(Avg) 0.0913 inch Length 18.000 ft Pitch 1.0000 inch
Tube Type Plain Material SA-179 Tube (S) K01200 Tube pattern 90

Shell	SA-516 70 Pl. K02700 ID 35.000 OD 37.000 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-350LF2CL1	Tubesheet-Floating	
Floating Head Cover		Impingement Plate	None

Baffles-Cross Type Support %Cut (Diam) Spacing(c/c) 30 Inlet 29.75 inch
Baffles-Long Seal Type None
Supports-Tube U-Bend Type None
Bypass Seal Arrangement pairs seal strips Tube-Tubesheet Joint Expanded and strength welded
Expansion Joint Type None
Rho-V2-Inlet Nozzle 157.34 lb/ft-sec2 Bundle Entrance Bundle Exit lb/ft-sec2

Gaskets-Shell Side 304 S.S. SPIRAL WOUND Tube Side 304 S.S. SPIRAL WOUND
- Floating Head
Code Requirements TEMA Class R
Weight/Shell 36900 lb Filled with Water 61800 lb Bundle 12350 lb

Remarks: Supports/baffle space = 7.

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Xist 9 (32 bit) 2/6/2023 3:23 SN: 13528-113450684 **US Units**
18-X-358-2 CORN OIL JET MODE - SOR
DIESEL PRODUCT MP STEAM GENERATOR : Shell 1
Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Exchanger Data

Unit identifier	Shell 1	
Service type	Generic shell and tube	
TEMA type	CKU	
Run mode	Rating	
Hot fluid location	Tubeside	
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	
Shellside gasket	304 S.S. SPIRAL WOUND	
Tubeside gasket	304 S.S. SPIRAL WOUND	
Shellside design pressure	550.00	psig
Tubeside design pressure	425.00	psig
Shellside vacuum pressure	Full	
Tubeside vacuum pressure	Full	
Shellside design temperature	550.00	F
Tubeside design temperature	650.00	F
Shellside corrosion allowance	0.1250	inch
Tubeside corrosion allowance	0.1250	inch
Tubesheet design temperature	650.00	F
Shellside radiography	Spot	
Tubeside radiography	Spot	
TEMA class	R	
Small exchanger	No	
Shell outside diameter	37.000	inch
Shell inside diameter	35.000	inch
Shell wall thickness	1.0000	inch
Front head outside diameter	37.75	inch
Front head inside diameter	35.5	inch
Front head thickness	0.625	inch
Rear head outside diameter	66.500	inch
Rear head inside diameter	64.000	inch
Rear head thickness	1.2500	inch
Total tubesheet thickness	4.6875	inch
Double tubesheet	No	
Shell expansion joint	No	
Suppress mechanical calculations	No	

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Reboiler Data

Reboiler type	Kettle reboiler	
Kettle inside diameter	64.000	inch
Height of liquid level	37.000	inch
Height of froth	5.0000	inch
Fraction entrainment	0.0010	lb liquid/lb vapor
Reference pressure location	At top of bundle	

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	18.000	ft
Tube material	SA-179 Tube (S) K01200	

Baffle Data

Baffle type	None	
Baffle thickness	0.6250	inch
Distance from tangent to last baffle	1.4375	inch
Use deresonating baffles	No	

Supports Data

Full support at U-Bend	None	
Support plates/baffle space	7	

Nozzle Data

Shellside

Nozzle standard	01-ANSI_B36_10.TABLE			
Shell entrance type	No impingement device			
Shell exit type	Remove tubes if TEMA requires			
	Inlet	**Outlet**	**Liq. Outlet**	
Nozzle outside diameter	4.5760	8.6250	--	inch
Nozzle inside diameter	3.8260	7.6250	--	inch
Number at this position	1	2	--	

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	--	

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Nozzle Location Data		
Radial position on shell inlet nozzle	Program decides	
Radial position on shell outlet nozzle	Program decides	
Location of nozzle at U-bend	After U-bend	
Tubeside entry type	Radial	
Tubeside inlet position	Front head	
Tubeside exit type	Same as inlet	

Tube Layout Data		
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	Calculated	
Block A stream	No	
Block E stream	No	
Block F stream	No	
Parallel/vertical passlane width	1.5000	inch
Perpendicular/horizontal passlane width	0.7500	inch
Number of passlane seal rods	None	
Tubes to remove for tie rods	None	
Number of tie rods	20	
Tie rod outside diameter	0.5000	inch
Baffle to shell clearance	0.1875	inch
Baffle clearance type	TEMA	

Process Conditions Data	**Hot Fluid**	**Cold Fluid**	
Phase condition	Sensible liquid	Two phase	
Flow rate	271.04	--	1000-lb/hr
Inlet vapor fraction	0.0000	0.0000	
Outlet vapor fraction	0.0000	0.9000	
Inlet temperature	556.00	225.00	F
Outlet temperature	425.00	--	F
Inlet pressure	124.70	189.70	psia
Allowable pressure drop	15.000	1.500	psi
Exchanger duty		25.600	MM Btu/hr
Duty multiplier		1.0000	

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

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Hot Fluid Property Data

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

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	556.00	425.00
Density, lb/ft3	34.400	38.630
Viscosity, cP	0.1590	0.2700
Thermal conductivity, Btu/hr-ft-F	0.0510	0.0570
Heat capacity, Btu/lb-F	0.7600	0.6840

Cold Fluid Property Data

Fluid name	BFW / STEAM
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	Mixed
Component quantity	1.0000

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Rating - Horizontal Multipass Flow TEMA CKU Shell With No Baffles

Control Name Data

Case name	DIESEL PRODUCT MP STEAM GENERATOR
Problem name	18-X-358-2 TALLOW DIESEL MODE - SOR
Job Number	S-16030-3-18-X-358-2CORNOILJETSORREV2
Item Number	18-X-358 (CORNOIL JET-SO
Reference Number	P.O # 4505600056
Proposal Number	S21-13258-3 REV3
Revision	D
Service	DIESEL PRODUCT MP STEAM GENERATOR
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	
Use modified heat release curves for kettles	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