



 Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
PO No.: GPIC-PT-MA-PO-000-3029	Document Number: VD-GPIC-MA-3029-3029-0026	Rev. 01	<b>Page 1 of 37</b>	

## Heat Exchangers Data Sheet (Condenser, Evaporator, Oil Cooler, Economizer)

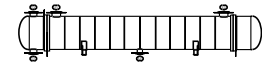
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05					
04					
03					
02					
01	14-July-25	IFR	A.M	F.T	A.M
00	29-Apr-25	IFR	A.M	F.T	A.M
<b>Rev.</b>	<b>DATE</b>	<b>PURPOSE OF ISSUE</b>	<b>PREPARED</b>	<b>CHECKED</b>	<b>APPROVED</b>



### Heat Exchanger Specification Sheet

1	For: Gach saran Polymer Industries Company (GPIC)	Condenser: TAG: E-6104
2	Project: HDPE	
3	PO No.: GPIC-PT-MA-PO-000-3029	
4	Site: -	
5	Service: Propylene Refrigeration Package	
6	Size: 1095 - 6000 mm	Type: BIM Horizontal Connected in: 1 parallel 1 series
7	Surf/unit(eff.) 584.1 m <sup>2</sup>	Shells/unit 1 Surf/shell(eff.) 584.1 m <sup>2</sup>
8	<b>PERFORMANCE OF ONE UNIT</b>	
9	Fluid allocation	Shell Side Tube Side
10	Fluid name	Propylene WATER
11	Fluid quantity, Total	27463 290000
12	Vapor (In/Out)	27463 0 0 0
13	Liquid	0 27463 290000 290000
14	Noncondensable	0 0 0 0
15		
16	Temperature (In/Out)	77.02 47.62 37 44.84
17	Bubble / Dew point	48.59 / 48.59 48.58 / 48.58 / /
18	Density Vapor/Liquid	35.84 / / 460.44 / 993.06 / 990.04
19	Viscosity	0.0111 / / 0.0604 / 0.7192 0.619
20	Molecular wt, Vap	42.08
21	Molecular wt, NC	
22	Specific heat	2.0217 / / 3.204 / 4.1774 / 4.1775
23	Thermal conductivity	0.0252 / / 0.0911 / 0.6220 / 0.6314
24	Latent heat	282.7 282.7
25	Pressure (abs)	19.68 19.67376 6.5 6.17041
26	Velocity (Mean/Max)	0.37 / 0.8 1.12 / 1.12
27	Pressure drop, allow./calc.	0.1 0.00624 0.5 0.32959
28	Fouling resistance (min)	0.0002 0.0002 0.00026 Ao based
29	Heat exchanged 2644.1 kW	MTD (corrected) 7.69 °C
30	Transfer rate, Service 588.6 Dirty 659 Clean 943 W/(m <sup>2</sup> -K)	
31	<b>CONSTRUCTION OF ONE SHELL</b>	
32		<b>Sketch</b>
33	Design/Vacuum/test pressure bar	25 / 1 / 32.5 28 / / 36.4
34	Design temperature / MDMT °C	125 / -45 190 / -29
35	Number passes per shell	1 4
36	Corrosion allowance mm	3 3
37	Connections In in	2 10 / 300 ANSI 1 8 / 300 ANSI
38	Size/Rating Out	1 6 / 300 ANSI 1 8 / 300 ANSI
39	Nominal Intermediate	/ 300 ANSI / 300 ANSI
40	Tube #: 1676 OD: 19.05 Tks. Average 2.11 mm Length: 6000 mm Pitch: 23.81 mm Tube pattern:30	
41	Tube type: Plain Insert:None Fin#: #/m Material:SA-334 6 K03006	
42	Shell SA-516 70 K02700-Normalized ID 1095 mm	Shell cover -
43	Channel or bonnet SA-516 70 K02700-Normalized	Channel cover -
44	Tubesheet-stationary SA-350 LF2 K03011 1-Normalized -	Tubesheet-floating -
45	Floating head cover -	Impingement protection Round plate
46	Baffle-cross SA-516 70 K02700-Normalized Type Single segmental Cut(%d) 40.87	VerticSpacing: c/c 480 mm
47	Baffle-long - Seal Type	Inlet 495.74 mm
48	Supports-tube U-bend 0	Type
49	Bypass seal	Tube-tubesheet joint Expanded & seal welded (2 grooves)(App.A 'f)
50	Expansion joint -	Type None
51	RhoV2-Inlet nozzle 161 Bundle entrance 120 Bundle exit 11	kg/(m-s <sup>2</sup> )
52	Gaskets - Shell side Spiral-Wound Metal Fib Tube side Spiral-Wound Metal Fib	
53	Floating head -	
54	Code requirements ASME Code Sec VIII Div 1 TEMA class R - refinery service	
55	Weight/Shell 15047.6 Filled with water 20624.5 Bundle 10303.6	kg
56	Remarks 1. GA DRAWING WILL BE SUBMITTED TO SHOW ALL THE NOZZLES	
57	2. MATERIAL ON SHELL SIDE IS DESIGNED FOR -45C	
58		






  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
PO No.: GPIC-PT-MA-PO-000-3029	Document Number: VD-GPIC-MA-3029-3029-0026		Rev. 01	<b>Page 4 of 37</b>

Thermal Details - Vibration Analysis - Fluid Elastic Instability HTFS

**Shell number: Shell 1**  
**Fluid Elastic Instability Analysis**






Vibration tube number	1	2	4	5
Vibration tube location	Inlet row, centre	Outer window, left	Baffle overlap	Bottom Row
Vibration	No	No	No	No
W/Wc for heavy damping (LDec=0.1)	0.02	0.06	0.02	0.02
W/Wc for medium damping (LDec=0.03)	0.03	0.11	0.03	0.03
W/Wc for light damping (LDec=0.01)	0.06	0.2	0.06	0.06
W/Wc for estimated damping	0.02	0.09	0.02	0.02
Estimated log Decrement	0.07	0.05	0.07	0.07
Tube natural frequency <b>cycle/s</b>	194.16	53.98	194.16	194.16
Natural frequency method	Exact Solution	Exact Solution	Exact Solution	Exact Solution
Dominant span				
Tube effective mass <b>kg/m</b>	1.17	1.17	1.17	1.17

Vibration tube number	6	8
Vibration tube location	Inlet row, end	Outer window, right
Vibration	No	No
W/Wc for heavy damping (LDec=0.1)	0.09	0.07
W/Wc for medium damping (LDec=0.03)	0.16	0.12
W/Wc for light damping (LDec=0.01)	0.28	0.22
W/Wc for estimated damping	0.12	0.09
Estimated log Decrement	0.05	0.06
Tube natural frequency <b>cycle/s</b>	53.98	49.53
Natural frequency method	Exact Solution	Dominant Span
Dominant span		Mid-space
Tube effective mass <b>kg/m</b>	1.17	1.17

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Note:  $W/W_c$  = ratio of actual shellside flowrate to critical flowrate for onset of fluid-elastic instability






Tube material density	kg/m <sup>3</sup>	7841.74
Tube axial stress	N/mm <sup>2</sup>	15.82
Tube material Young's Modulus	N/mm <sup>2</sup>	201571.3
U-bend longest unsupported length	mm	

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Resonance Analysis (HTFS)

**Shell number: Shell 1**  
**Resonance Analysis**






<b>Vibration tube number</b>		1	1	1	2
<b>Vibration tube location</b>		Inlet row, centre	Inlet row, centre	Inlet row, centre	Outer window, left
<b>Location along tube</b>		Inlet	Midspace	Outlet	Inlet
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	495.74	480	495.74	975.74
<b>Frequency ratio: Fv/Fn</b>		0.4	0.07	0.02	0.33
<b>Frequency ratio: Fv/Fa</b>		0.58	0.12	0	0.14
<b>Frequency ratio: Ft/Fn</b>		0.43	0.05	0.01	0.21
<b>Frequency ratio: Ft/Fa</b>		0.63	0.08	0	0.09
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	194.16	194.16	194.16	53.98
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	132.65	115.82	1160.4	132.65
<b>Flow velocity</b>	<b>m/s</b>	1.85	0.41	0.14	0.74
<b>X-flow fraction</b>		1	0.75	0.75	0.75
<b>RhoV2</b>	<b>kg/(m*s2)</b>	120	12	9	19
<b>Strouhal No.</b>		0.8	0.46	0.46	0.46

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<b>Vibration tube number</b>		2	2	4	4	4
<b>Vibration tube location</b>		Outer window, left	Outer window, left	Baffle overlap	Baffle overlap	Baffle overlap
<b>Location along tube</b>		Midspace	Outlet	Inlet	Midspace	Outlet
<b>Vibration problem</b>		No	No	No	No	No
<b>Span length</b>	<b>mm</b>	960	975.74	495.74	480	495.74
<b>Frequency ratio: Fv/Fn</b>		0.25	0.06	0.09	0.07	0.02
<b>Frequency ratio: Fv/Fa</b>		0.12	0	0.14	0.12	0
<b>Frequency ratio: Ft/Fn</b>		0.16	0.04	0.06	0.05	0.01
<b>Frequency ratio: Ft/Fa</b>		0.08	0	0.09	0.08	0
<b>Vortex shedding amplitude</b>	<b>mm</b>					
<b>Turbulent buffeting amplitude</b>	<b>mm</b>					
<b>TEMA amplitude limit</b>	<b>mm</b>					
<b>Natural freq., Fn</b>	<b>cycle/s</b>	53.98	53.98	194.16	194.16	194.16
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	115.82	1160.4	132.65	115.82	1160.4
<b>Flow velocity</b>	<b>m/s</b>	0.41	0.14	0.74	0.41	0.14
<b>X-flow fraction</b>		0.75	0.75	0.75	0.75	0.75
<b>RhoV2</b>	<b>kg/(m*s2)</b>	12	9	19	12	9
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46	0.46

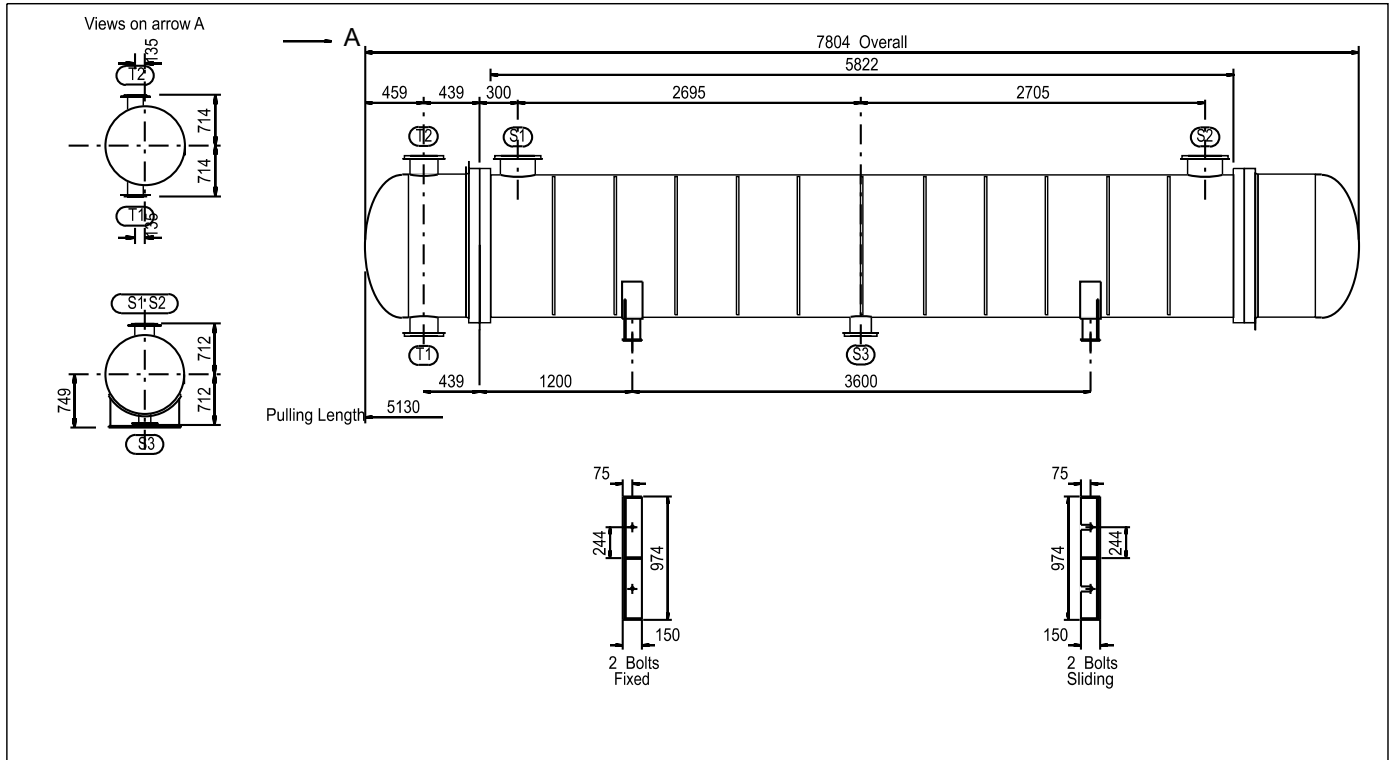
  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>					
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<b>Vibration tube number</b>		5	5	5	6	6	6
<b>Vibration tube location</b>		Bottom Row	Bottom Row	Bottom Row	Inlet row, end	Inlet row, end	Inlet row, end
<b>Location along tube</b>		Inlet	Midspace	Outlet	Inlet	Midspace	Outlet
<b>Vibration problem</b>		No	No	No	No	No	No
<b>Span length</b>	mm	495.74	480	495.74	975.74	960	975.74
<b>Frequency ratio: Fv/Fn</b>		0.09	0.07	0.03	1.43	0.44	0.06
<b>Frequency ratio: Fv/Fa</b>		0.14	0.12	0.01	0.58	0.2	0
<b>Frequency ratio: Ft/Fn</b>		0.06	0.05	0.04	1.55	0.47	0.04
<b>Frequency ratio: Ft/Fa</b>		0.09	0.08	0.01	0.63	0.22	0
<b>Vortex shedding amplitude</b>	mm						
<b>Turbulent buffeting amplitude</b>	mm						
<b>TEMA amplitude limit</b>	mm						
<b>Natural freq., Fn</b>	cycle/s	194.16	194.16	194.16	53.98	53.98	53.98
<b>Acoustic freq., Fa</b>	cycle/s	132.65	115.82	1160.4	132.65	115.82	1160.4
<b>Flow velocity</b>	m/s	0.74	0.41	0.15	1.85	0.41	0.14
<b>X-flow fraction</b>		0.75	0.75	1	0.75	0.75	0.75
<b>RhoV2</b>	kg/(m*s2)	19	12	11	120	12	9
<b>Strouhal No.</b>		0.46	0.46	0.8	0.46	0.46	0.46





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<b>Vibration tube number</b>		8	8	8
<b>Vibration tube location</b>		Outer window, right	Outer window, right	Outer window, right
<b>Location along tube</b>		Inlet	Midspace	Outlet
<b>Vibration problem</b>		No	No	No
<b>Span length</b>	mm	495.74	960	495.74
<b>Frequency ratio: Fv/Fn</b>		0.36	0.28	0.07
<b>Frequency ratio: Fv/Fa</b>		0.14	0.12	0
<b>Frequency ratio: Ft/Fn</b>		0.23	0.18	0.05
<b>Frequency ratio: Ft/Fa</b>		0.09	0.08	0
<b>Vortex shedding amplitude</b>	mm			
<b>Turbulent buffeting amplitude</b>	mm			
<b>TEMA amplitude limit</b>	mm			
<b>Natural freq., Fn</b>	cycle/s	49.53	49.53	49.53
<b>Acoustic freq., Fa</b>	cycle/s	132.65	115.82	1160.4
<b>Flow velocity</b>	m/s	0.74	0.41	0.14
<b>X-flow fraction</b>		0.75	0.75	0.75
<b>RhoV2</b>	kg/(m*s2)	19	12	9
<b>Strouhal No.</b>		0.46	0.46	0.46

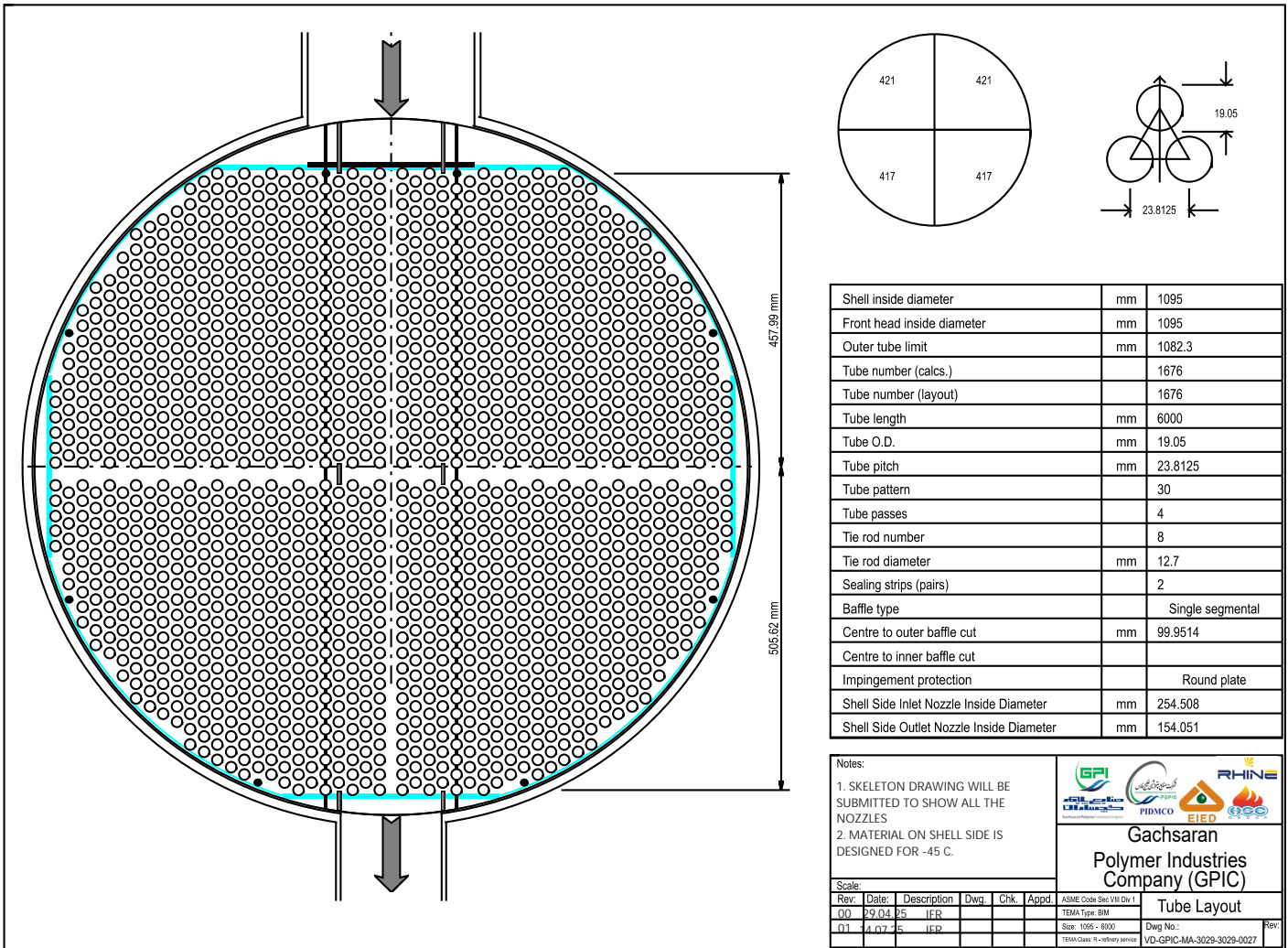
Setting Plan



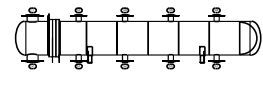
Nozzle Data				Design Data		Units	Shell	Channel	Notes:
Ref	OD	Wall	Standard	Notes	Design Pressure	bar	25	28	
S1	273 mm	9.3 mm	300 ANSI	Weld neck	Design Temperature	°C	125	190	1. SKELETON DRAWING WILL BE SUBMITTED TO SHOW ALL THE NOZZLES 2. MATERIAL ON SHELL SIDE IS DESIGNED FOR -45 C.
S2	273 mm	9.3 mm	300 ANSI	Weld neck	Full Vacuum				
S3	168 mm	7.1 mm	300 ANSI	Weld neck	Corrosion Allowance	mm	3	3	
T1	219 mm	8.2 mm	300 ANSI	Weld neck	Test Pressure	bar	32.5	36.4	
T2	219 mm	8.2 mm	300 ANSI	Weld neck	Number of Passes		1	4	
					Radiography				
					PWHT				
					Internal Volume	m <sup>3</sup>	2.6598	3.24	
					Weight Summary				
					Empty	Flooded	Bundle		
					15048 kg	20624 kg	10304 kg		






   
<b>Gachsaran Polymer Industries Company (GPIC)</b>
<b>Setting Plan</b>
ASME Section VIII Div. 1 TEMA Type: BIM Size: 1095 - 6000 TEMA Class: R
Dwg No.: Rev:

Tubesheet Layout



**Heat Exchanger Specification Sheet**

1	For: Gach saran Polymer Industries Company (GPIC)							
2	Project: HDPE			Chiller: TAG: E-6101				
3	PO No.: GPIC-PT-MA-PO-000-3029							
4	Site: -							
5	Service: Propylene Refrigeration Package							
6	Size: 1118 - 6096	mm	Type: BXU	Horizontal	Connected in: 1 parallel 1 series			
7	Surf/unit(eff.)	624.6	m <sup>2</sup>	Shells/unit 1	Surf/shell(eff.) 624.6 m <sup>2</sup>			
8	<b>PERFORMANCE OF ONE UNIT</b>							
9	Fluid allocation			Shell Side	Tube Side			
10	Fluid name			Propylene	Hexane			
11	Fluid quantity, Total	kg/h		22140	712800			
12	Vapor (In/Out)	kg/h	6824	22140	0 0			
13	Liquid	kg/h	15316	0	712800 712800			
14	Noncondensable	kg/h	0	0	0 0			
15								
16	Temperature (In/Out)	°C	-24.497	-24.58	-16 -20.5			
17	Bubble / Dew point	°C	-24.77 / -24.77	-24.85 / -24.85	/ /			
18	Density Vapor/Liquid	kg/m <sup>3</sup>	5.5692 / 580.75	5.6747 /	/ 691.99 / 695.76			
19	Viscosity	cp	0.0073 / 0.140	0.0072 /	/ 0.4568 / 0.4840			
20	Molecular wt, Vap		42.08	42.08				
21	Molecular wt, NC							
22	Specific heat	kJ/(kg-K)	1.401 / 2.2122	1.4002 /	/ 1.9674 / 1.949			
23	Thermal conductivity	W/(m-K)	0.0128 / 0.134	0.0127 /	/ 0.1341 / 0.1356			
24	Latent heat	kJ/kg	410.1	410.1				
25	Pressure (abs)	bar	2.617	2.60925	7 6.65947			
26	Velocity (Mean/Max)	m/s	0.83 / 1.26		2 / 2			
27	Pressure drop, allow./calc.	bar	0.01	0.00775	0.7 0.34053			
28	Fouling resistance (min)	m <sup>2</sup> -K/W	0.0002		0.0001 0.00013 Ao based			
29	Heat exchanged	1759.2	kW	MTD (corrected)	5.39 °C			
30	Transfer rate, Service	522.4	Dirty	578	Clean 713.5 W/(m <sup>2</sup> -K)			
31	<b>CONSTRUCTION OF ONE SHELL</b>				<b>Sketch</b>			
32		Shell Side		Tube Side				
33	Design/Vacuum/test pressure	bar	25 / 1 / 32.5	25 / 1 / 32.5				
34	Design temperature / MDMT	°C	125 / -45	125 / -45				
35	Number passes per shell		1	2				
36	Corrosion allowance	mm	3	3				
37	Connections	In	4 6.065 / 300 ANSI	1 13.25 / 300 ANSI				
38	Size/Rating	Out	4 6.065 / 300 ANSI	1 13.25 / 300 ANSI				
39	ID	Intermediate	/ 300 ANSI	/ 300 ANSI				
40	Tube #: 826 U's	OD: 19.05	Tks. Average 2.11	mm		Length: 6096 mm	Pitch: 23.81 mm	Tube pattern: 30
41	Tube type: Plain	Insert: None	Fin#: #/m	Material: SA-334 6 K03006				
42	Shell SA-516 70 K02700-Normalized	ID 1117.6	mm	Shell cover SA-516 70 K02700-Normalized				
43	Channel or bonnet SA-516 70 K02700-Normalized			Channel cover -				
44	Tubesheet-stationary SA-350 LF2 K03011 1-Normalized			Tubesheet-floating -				
45	Floating head cover -			Impingement protection Square plate				
46	Baffle-cross SA-516 70 K02700-Normalized	Type Unbaffled	Cut(%d)	Spacing: c/c	mm			
47	Baffle-long -	Seal Type		Inlet	mm			
48	Supports-tube U-bend	1	Type					
49	Bypass seal	Tube-tubesheet joint	Expanded & seal welded (2 grooves)(App.A 'f')					
50	Expansion joint -	Type None						
51	RhoV2-Inlet nozzle 403	Bundle entrance 2	Bundle exit 8		kg/(m <sup>2</sup> -s)			
52	Gaskets - Shell side	Flat Metal Jacket Fibe	Tube side	Flat Metal Jacket Fibe				
53	Floating head	-						
54	Code requirements	ASME Code Sec VIII Div 1	TEMA class R - refinery service					
55	Weight/Shell	15264.6	Filled with water 22374.2	Bundle 10609.8	kg			
56	Remarks	1. GA DRAWING WILL BE SUBMITTED TO SHOW ALL THE NOZZLES						
57		2. MATERIAL ON SHELL and TUBE SIDES ARE DESIGNED FOR -45C						
58								

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Thermal Details - Vibration Analysis - Fluid Elastic Instability HTFS






Shell number: Shell 1

**Fluid Elastic Instability Analysis**

<b>Vibration tube number</b>		3	4
<b>Vibration tube location</b>		Bottom Row	Top row
<b>Vibration</b>		No	No
<b>W/Wc for heavy damping (LDec=0.1)</b>		0.05	0.05
<b>W/Wc for medium damping (LDec=0.03)</b>		0.09	0.09
<b>W/Wc for light damping (LDec=0.01)</b>		0.16	0.16
<b>W/Wc for estimated damping</b>		0.08	0.08
<b>Estimated log Decrement</b>		0.04	0.04
<b>Tube natural frequency</b>	<b>cycle/s</b>	45.73	45.73
<b>Natural frequency method</b>		Dominant Span	Dominant Span
<b>Dominant span</b>		Mid-space	Outlet
<b>Tube effective mass</b>	<b>kg/m</b>	1.01	1.01

Note: W/Wc = ratio of actual shellside flowrate to critical flowrate for onset of fluid-elastic instability

Tube material density	kg/m <sup>3</sup>	7841.74
Tube axial stress	N/mm <sup>2</sup>	0
Tube material Young's Modulus	N/mm <sup>2</sup>	205282.1
U-bend longest unsupported length	mm	702.75

  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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Resonance Analysis (HTFS)

Shell number: Shell 1

Resonance Analysis

Vibration tube number		3	4
Vibration tube location		Bottom Row	Top row
Location along tube		Midspace	Midspace
Vibration problem		No	No
Span length	mm	752.48	996.16
Frequency ratio: Fv/Fn		0.19	0.61
Frequency ratio: Fv/Fa		0.12	0.22
Frequency ratio: Ft/Fn		0.12	0.39
Frequency ratio: Ft/Fa		0.08	0.14
Vortex shedding amplitude	mm		
Turbulent buffeting amplitude	mm		
TEMA amplitude limit	mm		
Natural freq., Fn	cycle/s	45.73	45.73
Acoustic freq., Fa	cycle/s	71.97	126.91
Flow velocity	m/s	0.37	1.14
X-flow fraction		1	1
RhoV2	kg/(m*s2)	2	7
Strouhal No.		0.46	0.46



**Gachसान Polymer Industries Company  
HDPE Plant**

**Heat Exchangers Data Sheet  
(Condenser, Evaporator, Oil Cooler,  
Economizer)**



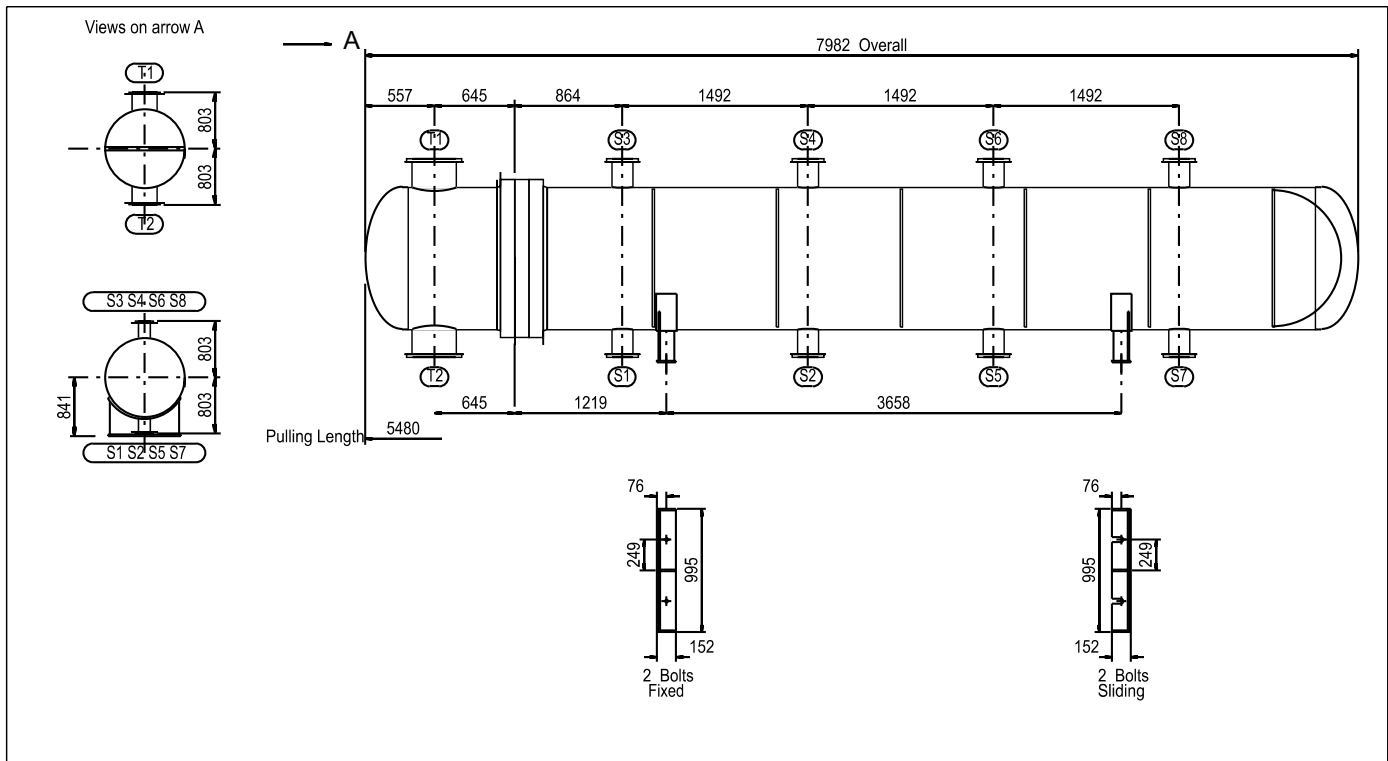
PO No.: GPIC-PT-MA-PO-000-3029

Document Number: VD-GPIC-MA-3029-3029-0026

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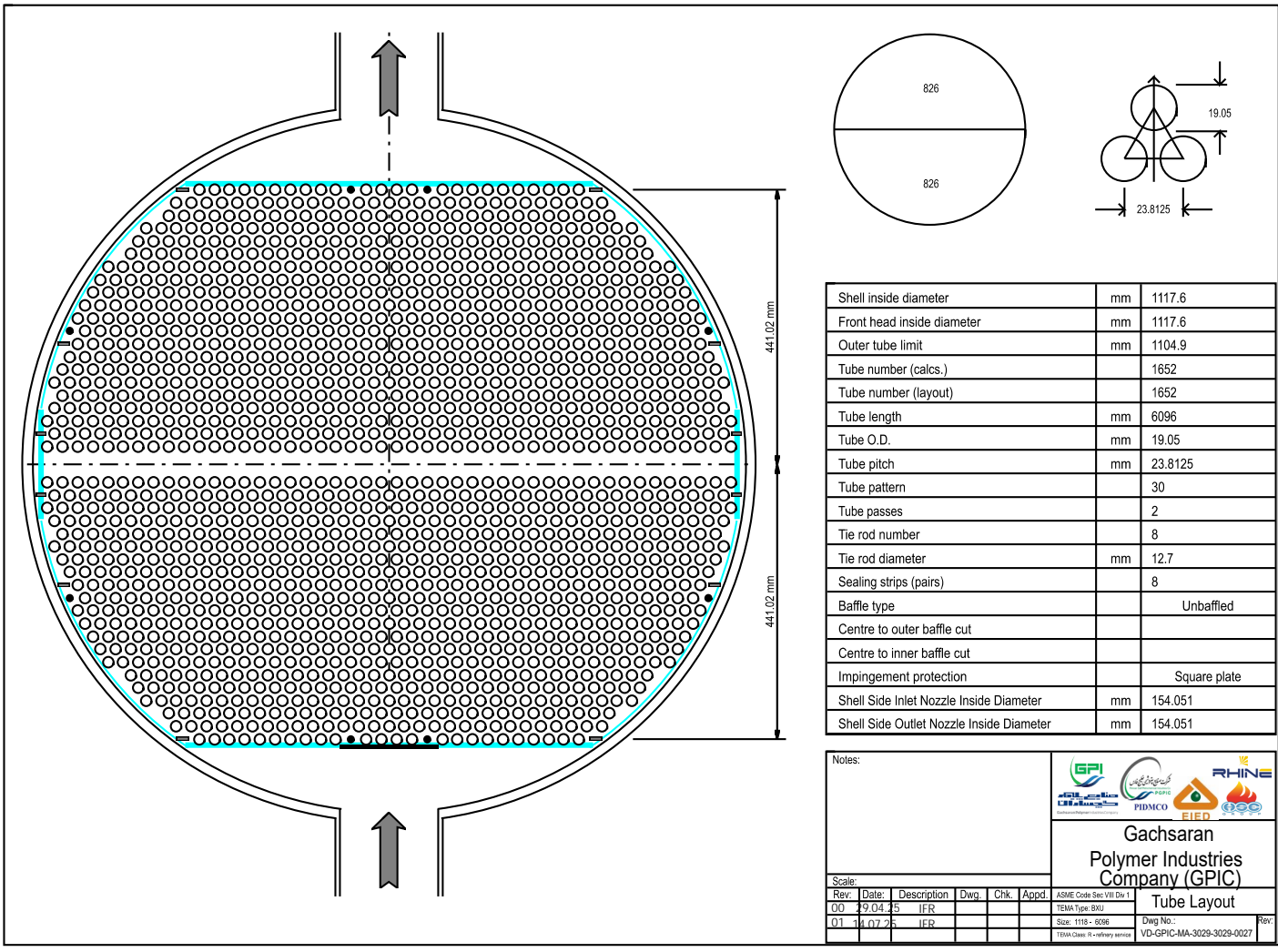
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Setting Plan




Nozzle Data				Design Data		Units	Shell	Channel	Notes:								
Ref	OD	Wall	Standard	Notes	Design Pressure	bar	25	25									
S1	168 mm	7.1 mm	300 ANSI	Weld neck	Design Temperature	°C	125	125									
S2	168 mm	7.1 mm	300 ANSI	Weld neck	Full Vacuum												
S3	168 mm	7.1 mm	300 ANSI	Weld neck	Corrosion Allowance	mm	3	3									
S4	168 mm	7.1 mm	300 ANSI	Weld neck	Test Pressure	bar	32.5	32.5									
S5	168 mm	7.1 mm	300 ANSI	Weld neck	Number of Passes		1	2									
S6	168 mm	7.1 mm	300 ANSI	Weld neck	Radiography												
S7	168 mm	7.1 mm	300 ANSI	Weld neck	PWHT												
T1	356 mm	9.5 mm	300 ANSI	Weld neck	Internal Volume	m³	3.3696	2.9943									
T2	356 mm	9.5 mm	300 ANSI	Weld neck													
				Weight Summary					Scale:	Rev.	Date:	Description	Dwg.	Chk.	Appd.	ASME Section VIII Div. 1	Setting Plan
				Empty	Flooded	Bundle			00	29.04.25	IFR					ITEMA Type: BXU	
				15264 kg	22374 kg	10609 kg			01	14.07.25	IFR					Size: 1118 - 6096	Dwg No.: VD-GPIC-MA-3029-3029-0027
																ITEMA Class: R	Rev:

**Tubesheet Layout**








Shell inside diameter	mm	1117.6
Front head inside diameter	mm	1117.6
Outer tube limit	mm	1104.9
Tube number (calcs.)		1652
Tube number (layout)		1652
Tube length	mm	6096
Tube O.D.	mm	19.05
Tube pitch	mm	23.8125
Tube pattern		30
Tube passes		2
Tie rod number		8
Tie rod diameter	mm	12.7
Sealing strips (pairs)		8
Baffle type		Unbaffled
Centre to outer baffle cut		
Centre to inner baffle cut		
Impingement protection		Square plate
Shell Side Inlet Nozzle Inside Diameter	mm	154.051
Shell Side Outlet Nozzle Inside Diameter	mm	154.051

Notes:



**Gachsaran Polymer Industries Company (GPIC)**






Scale:					ASME Code Sec VIII Div 1	Tube Layout	Dwg No.: VD-GPIC-MA-3029-0027	REV:
Rev.	Date:	Description	Dwg.	Chk.	Appd.			
00	29.04.25	IFR				Size: 1118 - 6096		
01	14.07.25	IFR				TEMA Class: R - ordinary service		

  Gachсарan Polymer Industries Company	<b>Gachсарan Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
PO No.: GPIC-PT-MA-PO-000-3029	Document Number: VD-GPIC-MA-3029-3029-0026		Rev. 01	Page 17 of 37

TEMA Sheet

**Heat Exchanger Specification Sheet**

1	For: Gachсарan Polymer Industries Company (GPIC)				
2	Project: HDPE			Oil Cooler TAG: E-6102	
3	PO No.: GPIC-PT-MA-PO-000-3029				
4	Site: -				
5	Service: Propylene Refrigeration Package				
6	Size:	381 - 5250 mm	Type:	AEU Horizontal	Connected in: 1 parallel 1 series
7	Surf/unit(eff.)	51.7 m <sup>2</sup>	Shells/unit	1	Surf/shell(eff.) 51.7 m <sup>2</sup>
8	<b>PERFORMANCE OF ONE UNIT</b>				
9	Fluid allocation	Shell Side		Tube Side	
10	Fluid name	Lube Oil - PAG		Water	
11	Fluid quantity, Total	15095 kg/h		40000	
12	Vapor (In/Out)	0 kg/h	0 kg/h	0	0
13	Liquid	15095 kg/h	15095 kg/h	40000	40000
14	Noncondensable	0 kg/h	0 kg/h	0	0
15					
16	Temperature (In/Out)	92.5 °C	50.19 °C	37 °C	44.65 °C
17	Bubble / Dew point	/ °C	/ °C	/ °C	/ °C
18	Density Vapor/Liquid	/ 873.48 kg/m <sup>3</sup>	/ 916.33 kg/m <sup>3</sup>	/ 993.06 kg/m <sup>3</sup>	/ 989.96 kg/m <sup>3</sup>
19	Viscosity	/ 12.2583 mPa-s	/ 36.3211 mPa-s	/ 0.7192 mPa-s	/ 0.6161 mPa-s
20	Molecular wt, Vap				
21	Molecular wt, NC				
22	Specific heat	/ 2.054 kJ/(kg-K)	/ 1.962 kJ/(kg-K)	/ 4.1774 kJ/(kg-K)	/ 4.1776 kJ/(kg-K)
23	Thermal conductivity	/ 0.1507 W/(m-K)	/ 0.1582 W/(m-K)	/ 0.6220 W/(m-K)	/ 0.6318 W/(m-K)
24	Latent heat				
25	Pressure (abs)	24.2 bar	24.04908 bar	6.5 bar	6.02248 bar
26	Velocity (Mean/Max)	0.16 / 0.34 m/s		1.6 / 1.62 m/s	
27	Pressure drop, allow./calc.	0.7 bar	0.15092 bar	0.5 bar	0.47751 bar
28	Fouling resistance (min)	0.0002 m <sup>2</sup> -K/W		0.0002	0.00026 Ao based
29	Heat exchanged	355.9 kW	MTD (corrected)		24.64 °C
30	Transfer rate, Service	279.1 Dirty	305.9 Clean	355.6	W/(m <sup>2</sup> -K)
31	<b>CONSTRUCTION OF ONE SHELL</b>				<b>Sketch</b>
32		Shell Side		Tube Side	
33	Design/Vacuum/test pressure	28 bar	1 / 36.4	28 bar	1 / 36.4
34	Design temperature / MDMT	125 °C	/ -29	190 °C	/ -29
35	Number passes per shell	1		4	
36	Corrosion allowance	3 mm		3 mm	
37	Connections	In	1 3 / 300 ANSI	1 4 / 300 ANSI	
38	Size/Rating	Out	1 3 / 300 ANSI	1 4 / 300 ANSI	
39	Nominal	Intermediate	/ 300 ANSI	/ 300 ANSI	
40	Tube #:	81 U's	OD: 19.05 mm	Tks. Average 2.11 mm	Length: 5250 mm
41	Tube type:	Plain	Insert:None	Fin#:	#/m
42	Shell	SA-516 70 K02700-Normalized	ID 381 mm	Shell cover	SA-516 70 K02700-Normalized
43	Channel or bonnet	SA-516 70 K02700-Normalized		Channel cover	SA-516 70 K02700-Normalized
44	Tubesheet-stationary	SA-266 2 K03506-Normalized	-	Tubesheet-floating	-
45	Floating head cover	-		Impingement protection	None
46	Baffle-cross	SA-516 70 K02700-Normalized	Type Single segmental	Cut(%d) 19.19	HorizSpacing: c/c 300 mm
47	Baffle-long	-	Seal Type	Inlet	0 mm
48	Supports-tube	U-bend	0	Type	
49	Bypass seal	-	Tube-tubesheet joint	Expanded & seal welded (2 grooves)(App.A 'f')	
50	Expansion joint	-	Type	None	
51	RhoV2-Inlet nozzle	885	Bundle entrance 71	Bundle exit 26	kg/(m-s <sup>2</sup> )
52	Gaskets - Shell side	Spiral-Wound Metal Fib		Tube side Spiral-Wound Metal Fib	
53	Floating head				
54	Code requirements	ASME Code Sec VIII Div 1		TEMA class C - general service	
55	Weight/Shell	1573.9	Filled with water 2139.9	Bundle 867.8	kg
56	Remarks	1. GA DRAWING WILL BE SUBMITTED TO SHOW ALL THE NOZZLES			
57		2. MATERIAL ON SHELL and TUBE SIDES ARE DESIGNED FOR -29C			
58		3. THIS COOLER IS DESIGNED TO COVER UNLOADED COMPRESSOR WHERE HEAT LOAD IS HIGHEST			




  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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Thermal Details - Vibration Analysis - Fluid Elastic Instability HTFS

**Shell number: Shell 1**  
**Fluid Elastic Instability Analysis**






Vibration tube number	1	2	4	5
Vibration tube location	Inlet row, centre	Outer window, bottom	Baffle overlap	Bottom Row
Vibration	No	No	No	No
W/Wc for heavy damping (LDec=0.1)	0.03	0.12	0.06	0.08
W/Wc for medium damping (LDec=0.03)	0.06	0.21	0.11	0.15
W/Wc for light damping (LDec=0.01)	0.1	0.37	0.2	0.26
W/Wc for estimated damping	0.04	0.1	0.08	0.07
Estimated log Decrement	0.09	0.13	0.07	0.13
Tube natural frequency	102.93	48.2	174.45	52.59
Natural frequency method	Dominant Span	Dominant Span	Dominant Span	Dominant Span
Dominant span	Mid-space	U-bend	U-bend	U-bend
Tube effective mass	1.48	1.48	1.48	1.48

Vibration tube number	6	8
Vibration tube location	Inlet row, end	Outer window, top
Vibration	No	No
W/Wc for heavy damping (LDec=0.1)	0.03	0.04
W/Wc for medium damping (LDec=0.03)	0.06	0.08
W/Wc for light damping (LDec=0.01)	0.1	0.14
W/Wc for estimated damping	0.04	0.05
Estimated log Decrement	0.09	0.09
Tube natural frequency	102.93	102.93
Natural frequency method	Dominant Span	Dominant Span
Dominant span	Mid-space	Mid-space
Tube effective mass	1.48	1.48

	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>		
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		
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Note:  $W/W_c$  = ratio of actual shellside flowrate to critical flowrate for onset of fluid-elastic instability






Tube material density	kg/m <sup>3</sup>	7841.74
Tube axial stress	N/mm <sup>2</sup>	0
Tube material Young's Modulus	N/mm <sup>2</sup>	201576.8
U-bend longest unsupported length	mm	876.79

  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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Resonance Analysis (HTFS)






**Shell number: Shell 1**  
**Resonance Analysis**

<b>Vibration tube number</b>		1	1	1	2
<b>Vibration tube location</b>		Inlet row, centre	Inlet row, centre	Inlet row, centre	Outer window, bottom
<b>Location along tube</b>		U-bend	Midspace	Outlet	U-bend
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	94.77	600	399.2	576.79
<b>Frequency ratio: Fv/Fn</b>		0.07	0.11	0.04	0.32
<b>Frequency ratio: Fv/Fa</b>		0	0	0	0.01
<b>Frequency ratio: Ft/Fn</b>		0.04	0.07	0.03	0.2
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	102.93	102.93	102.93	48.2
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	2434.88	2380.22	2377.41	2434.88
<b>Flow velocity</b>	<b>m/s</b>	0.28	0.15	0.17	0.63
<b>X-flow fraction</b>		1	0.76	1	0.76
<b>RhoV2</b>	<b>kg/(m*s2)</b>	71	26	26	344
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46






  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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<b>Vibration tube number</b>		2	2	4	4
<b>Vibration tube location</b>		Outer window, bottom	Outer window, bottom	Baffle overlap	Baffle overlap
<b>Location along tube</b>		Midspace	Outlet	U-bend	Midspace
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	600	699.2	431.41	300
<b>Frequency ratio: Fv/Fn</b>		0.32	0.06	0.1	0.1
<b>Frequency ratio: Fv/Fa</b>		0.01	0	0.01	0.01
<b>Frequency ratio: Ft/Fn</b>		0.2	0.04	0.06	0.06
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	48.2	48.2	174.45	174.45
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	2380.22	2377.41	2434.88	2380.22
<b>Flow velocity</b>	<b>m/s</b>	0.2	0.11	0.71	0.22
<b>X-flow fraction</b>		0.76	0.76	0.76	0.76
<b>RhoV2</b>	<b>kg/(m*s2)</b>	45	12	440	58
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46

		4	5	5	5	6
<b>Vibration tube number</b>						
<b>Vibration tube location</b>		Baffle overlap	Bottom Row	Bottom Row	Bottom Row	Inlet row, end
<b>Location along tube</b>		Outlet	U-bend	Midspace	Outlet	U-bend
<b>Vibration problem</b>		No	No	No	No	No
<b>Span length</b>	<b>mm</b>	399.2	539.39	600	699.2	244.39
<b>Frequency ratio: Fv/Fn</b>		0.02	0.22	0.22	0.04	0.07
<b>Frequency ratio: Fv/Fa</b>		0	0	0	0	0
<b>Frequency ratio: Ft/Fn</b>		0.01	0.14	0.14	0.03	0.04
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>					
<b>Turbulent buffeting amplitude</b>	<b>mm</b>					
<b>TEMA amplitude limit</b>	<b>mm</b>					
<b>Natural freq., Fn</b>	<b>cycle/s</b>	174.45	52.59	52.59	52.59	102.93
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	2377.41	2434.88	2380.22	2377.41	2434.88
<b>Flow velocity</b>	<b>m/s</b>	0.13	0.48	0.15	0.09	0.28
<b>X-flow fraction</b>		0.76	0.76	0.76	0.76	0.76
<b>RhoV2</b>	<b>kg/(m*s2)</b>	15	199	26	7	71
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46	0.46

  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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<b>Vibration tube number</b>		6	6	8	8
<b>Vibration tube location</b>		Inlet row, end	Inlet row, end	Outer window, top	Outer window, top
<b>Location along tube</b>		Midspace	Outlet	U-bend	Midspace
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	600	399.2	281.79	600
<b>Frequency ratio: Fv/Fn</b>		0.11	0.04	0.24	0.15
<b>Frequency ratio: Fv/Fa</b>		0	0	0.01	0.01
<b>Frequency ratio: Ft/Fn</b>		0.07	0.03	0.15	0.1
<b>Frequency ratio: Ft/Fa</b>		0	0	0.01	0
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	102.93	102.93	102.93	102.93
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	2380.22	2377.41	2434.88	2380.22
<b>Flow velocity</b>	<b>m/s</b>	0.15	0.17	1	0.2
<b>X-flow fraction</b>		0.76	0.76	0.76	0.76
<b>RhoV2</b>	<b>kg/(m*s2)</b>	26	26	868	45
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46

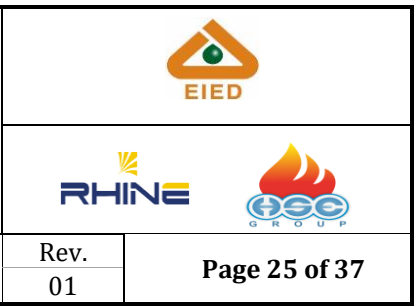
  Gachsaran Polymer Industries Company PIDMCO	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>		
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 
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<b>Vibration tube number</b>		8
<b>Vibration tube location</b>		Outer window, top
<b>Location along tube</b>		Outlet
<b>Vibration problem</b>		No
<b>Span length</b>	mm	399.2
<b>Frequency ratio: Fv/Fn</b>		0.04
<b>Frequency ratio: Fv/Fa</b>		0
<b>Frequency ratio: Ft/Fn</b>		0.03
<b>Frequency ratio: Ft/Fa</b>		0
<b>Vortex shedding amplitude</b>	mm	
<b>Turbulent buffeting amplitude</b>	mm	
<b>TEMA amplitude limit</b>	mm	
<b>Natural freq., Fn</b>	cycle/s	102.93
<b>Acoustic freq., Fa</b>	cycle/s	2377.41
<b>Flow velocity</b>	m/s	0.18
<b>X-flow fraction</b>		0.76
<b>RhoV2</b>	kg/(m*s2)	30
<b>Strouhal No.</b>		0.46



**Gachsaran Polymer Industries Company  
HDPE Plant**

**Heat Exchangers Data Sheet  
(Condenser, Evaporator, Oil Cooler,  
Economizer)**



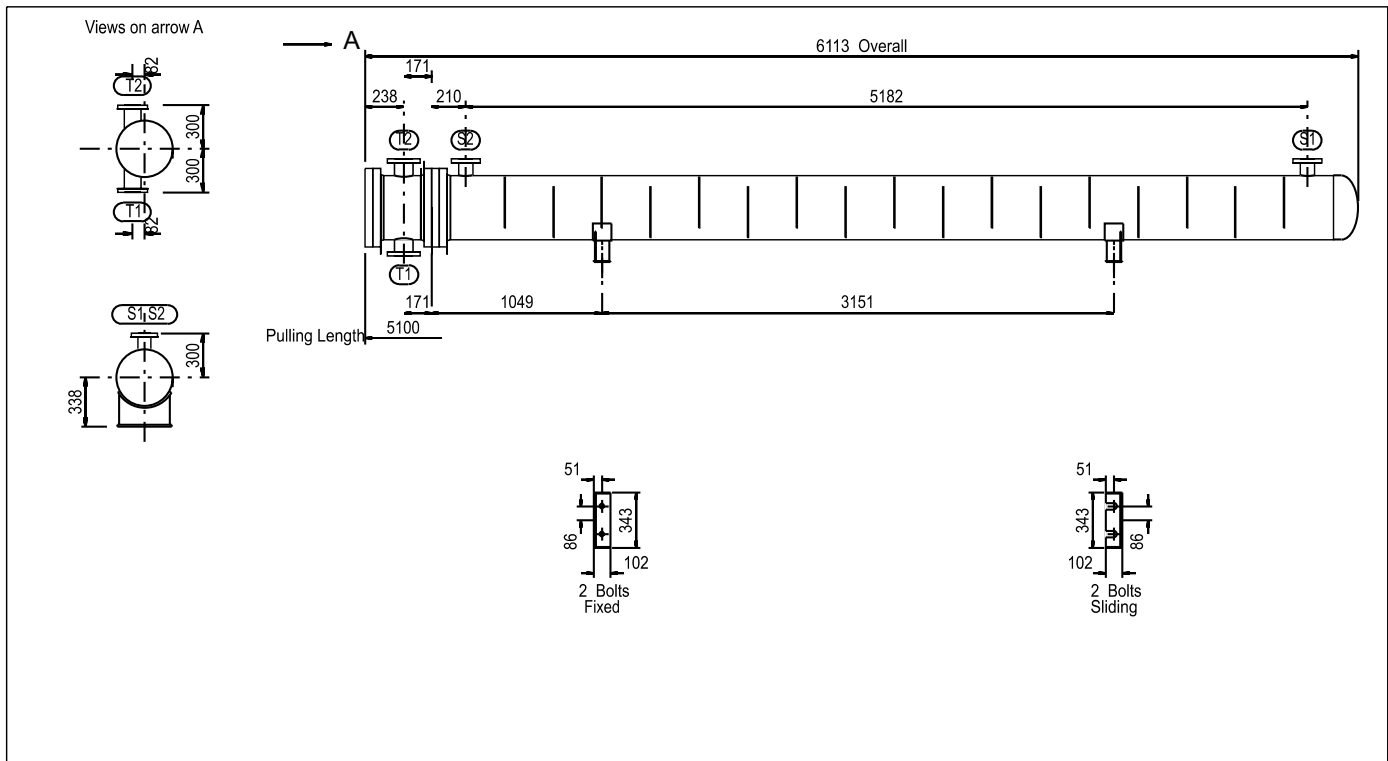
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**Setting Plan**



Nozzle Data				Design Data		Units	Shell	Channel	Notes:
Ref	OD	Wall	Standard	Design Pressure	bar	28	28	<p align="center"><b>Gachsaran Polymer Industries Company (GPIC)</b></p>	
S1	89 mm	5.5 mm	300 ANSI Weld neck	Design Temperature	°C	125	190		
S2	89 mm	5.5 mm	300 ANSI Weld neck	Full Vacuum					
T1	114 mm	6 mm	300 ANSI Weld neck	Corrosion Allowance	mm	3	3		
T2	114 mm	6 mm	300 ANSI Weld neck	Test Pressure	bar	36.4	36.4		
				Number of Passes		1	4		
				Radiography					
				PWHT					
				Internal Volume	m <sup>3</sup>	0.3862	0.196		
				Weight Summary					
				Empty	Flooded	Bundle			
				1574 kg	2140 kg	868 kg			

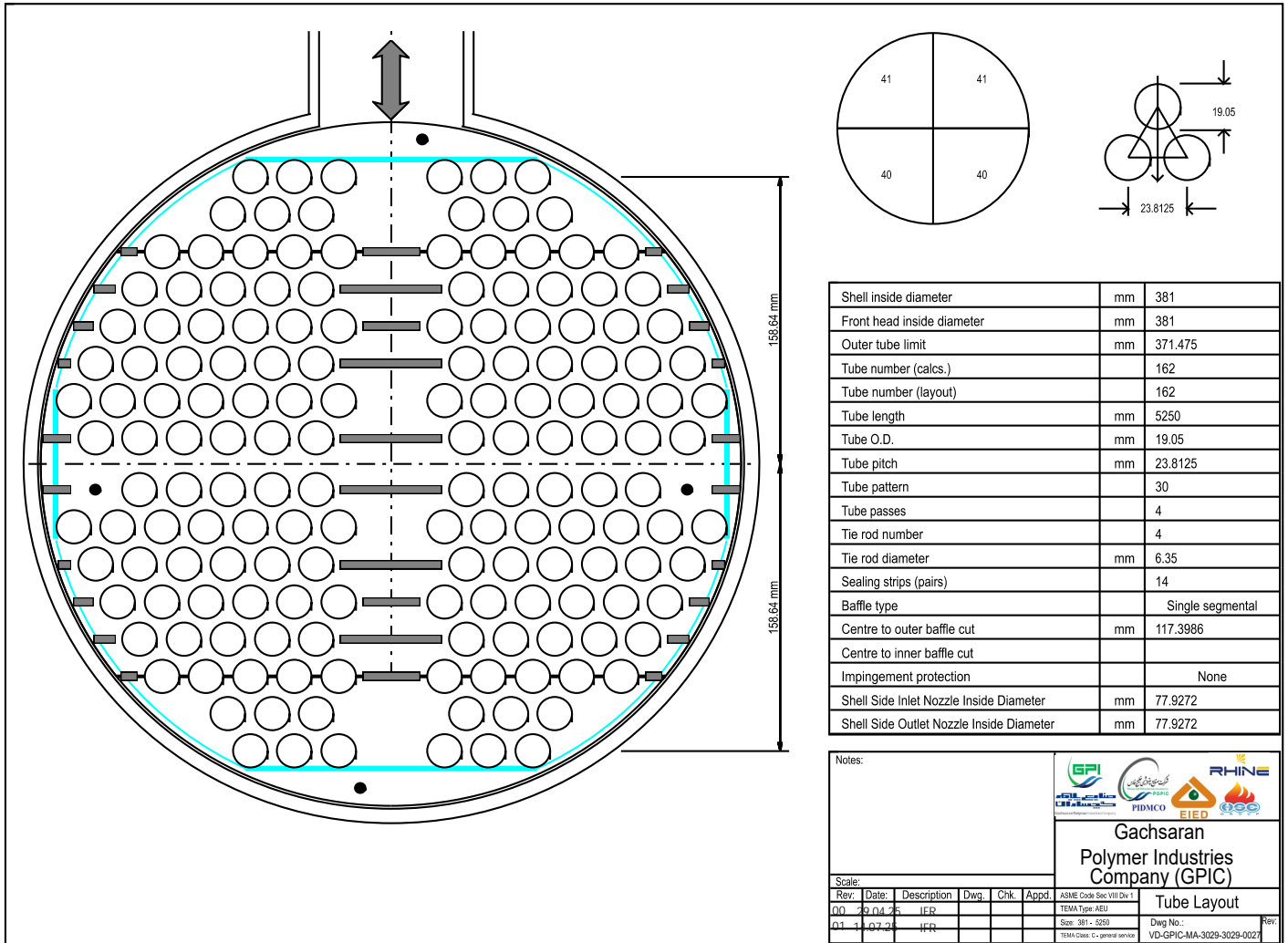
  






Rev.	Date:	Description	Dwg.	Chk.	Appd.
00	20.04.25	IFR			
01	14.07.25	IFR			

ASME Section VIII Div. 1	<b>Setting Plan</b>
TEMA Type: AEU	
Size: 381 - 5250	
TEMA Class: C	Dwg No.: VD-GPIC-MA-3029-3029-0027
	Rev:

Tubesheet Layout

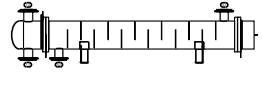







  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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U-bend Schedule

Number of U-tubes	U-bend diameter	U-bend length	U-tube length
	mm	mm	mm
8	57.15	89.77	10589.77
8	80.96	127.18	10627.18
8	104.78	164.58	10664.58
8	128.59	201.98	10701.98
8	152.4	239.39	10739.39
8	176.21	276.79	10776.79
6	200.02	314.2	10814.2
6	223.84	351.6	10851.6
6	247.65	389.01	10889.01
6	271.46	426.41	10926.41
4	295.27	463.82	10963.82
3	319.09	501.22	11001.22
2	342.9	538.63	11038.63

### Heat Exchanger Specification Sheet

1	For: Gachsaran Polymer Industries Company (GPIC)							
2	Project: HDPE			Economizer TAG: E-6103				
3	PO No.: GPIC-PT-MA-PO-000-3029							
4	Site: -							
5	Service: Propylene Refrigeration Package							
6	Size:	356 - 2438.4 mm	Type:	BEM Horizontal	Connected in:	1 parallel 1 series		
7	Surf/unit(eff.)	22.6 m <sup>2</sup>	Shells/unit	1	Surf/shell(eff.)	22.6 m <sup>2</sup>		
8	<b>PERFORMANCE OF ONE UNIT</b>							
9	Fluid allocation	Shell Side		Tube Side				
10	Fluid name	Propylene		Propylene				
11	Fluid quantity, Total	22140 kg/h		5323 kg/h				
12	Vapor (In/Out)	0 kg/h	0 kg/h	1679 kg/h	5323 kg/h			
13	Liquid	22140 kg/h	22140 kg/h	3644 kg/h	0 kg/h			
14	Noncondensable	0 kg/h	0 kg/h	0 kg/h	0 kg/h			
15								
16	Temperature (In/Out)	°C	47.62	27.05	5.905	7.65		
17	Bubble / Dew point	°C	/	/	5.95 / 5.95	5.74 / 5.74		
18	Density Vapor/Liquid	kg/m <sup>3</sup>	/ 460.43	/ 500.65	14.57 / 536.08	14.310 /		
19	Viscosity	cP	/ 0.0603	/ 0.0802	0.0084 / 0.1018	0.0084 /		
20	Molecular wt, Vap				42.08	42.08		
21	Molecular wt, NC							
22	Specific heat	kJ/(kg-K)	/ 3.308	/ 2.765	1.602 / 2.506	1.604 /		
23	Thermal conductivity	W/(m-K)	/ 0.0911	/ 0.997	0.0162 / 0.1086	0.0164 /		
24	Latent heat	kJ/kg			365.3	365.3		
25	Pressure (abs)	bar	19.677		6.96			
26	Velocity (Mean/Max)	m/s	0.63 / 0.77		3.78 / 7.65			
27	Pressure drop, allow./calc.	bar	0.25	0.07017	0.05	0.04167		
28	Fouling resistance (min)	m <sup>2</sup> -K/W	0.0002		0.0002	0.00026 Ao based		
29	Heat exchanged	384.7 kW	MTD (corrected)		30.45 °C			
30	Transfer rate, Service	559.9	Dirty	634.8	Clean	894.1 W/(m <sup>2</sup> -K)		
31	<b>CONSTRUCTION OF ONE SHELL</b>			<b>Sketch</b>				
32		Shell Side	Tube Side					
33	Design/Vacuum/test pressure	bar	25 / 1 / 32.5	25 / 1 / 32.5				
34	Design temperature / MDMT	°C	125 / -45	125 / -45				
35	Number passes per shell		1	2				
36	Corrosion allowance	mm	3	3				
37	Connections	In	1 4" / 300 ANSI	1 3" / 300 ANSI				
38	Size/Rating	Out	1 4" / 300 ANSI	1 6" / 300 ANSI				
39	Nominal	Intermediate	/ 300 ANSI	/ 300 ANSI				
40	Tube #: 160	OD: 19.05	Tks. Average 2.11 mm	Length: 2438.4 mm			Pitch: 23.81 mm	Tube pattern:30
41	Tube type: Plain	Insert:None	Fin#: -	#/m -			Material:SA-334 6 K03006	
42	Shell SA-516 70 K02700	Normalized ID 355.6	mm	Shell cover	-			
43	Channel or bonnet SA-516 70 K02700	Normalized		Channel cover	-			
44	Tubesheet-stationary SA-350 LF2 K03011	1-Normalized	-	Tubesheet-floating	-			
45	Floating head cover	-		Impingement protection	None			
46	Baffle-cross SA-516 70 K02700	Normalized	Type Single segmental	Cut(%d) 33.9	Horiz Spacing: c/c	171.5 mm		
47	Baffle-long -	Seal Type		Inlet	234.9 mm			
48	Supports-tube	U-bend	0	Type				
49	Bypass seal		Tube-tubesheet joint	Expanded & seal welded (2 grooves)(App.A'f)				
50	Expansion joint	-	Type	None				
51	RhoV2-Inlet nozzle 1990		Bundle entrance 376	Bundle exit 344	kg/(m <sup>2</sup> -s <sup>2</sup> )			
52	Gaskets - Shell side	Spiral-Wound Metal Fib		Tube side	Spiral-Wound Metal Fib			
53	Floating head	-						
54	Code requirements	ASME Code Sec VIII Div 1		TEMA class	R - refinery service			
55	Weight/Shell	918	Filled with water 1158.5	Bundle 431.1	kg			
56	Remarks	1. GA DRAWING WILL BE SUBMITTED TO SHOW ALL THE NOZZLES						
57		2. MATERIAL ON SHELL AND TUBE SIDES ARE DESIGNED FOR -45C						
58								




  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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Thermal Details - Vibration Analysis - Fluid Elastic Instability HTFS

**Shell number: Shell 1**  
**Fluid Elastic Instability Analysis**






Vibration tube number	1	2	4	5
Vibration tube location	Inlet row, centre	Outer window, bottom	Baffle overlap	Bottom Row
Vibration	No	No	No	No
W/Wc for heavy damping (LDec=0.1)	0.01	0.02	0.01	0.01
W/Wc for medium damping (LDec=0.03)	0.01	0.04	0.01	0.01
W/Wc for light damping (LDec=0.01)	0.02	0.07	0.02	0.02
W/Wc for estimated damping	0.01	0.04	0.01	0.01
Estimated log Decrement	0.04	0.04	0.04	0.04
Tube natural frequency <b>cycle/s</b>	384.18	384.18	1268.63	384.18
Natural frequency method	Exact Solution	Exact Solution	Exact Solution	Exact Solution
Dominant span				
Tube effective mass <b>kg/m</b>	1.12	1.12	1.12	1.12

Vibration tube number	6	8
Vibration tube location	Inlet row, end	Outer window, top
Vibration	No	No
W/Wc for heavy damping (LDec=0.1)	0.01	0.02
W/Wc for medium damping (LDec=0.03)	0.01	0.04
W/Wc for light damping (LDec=0.01)	0.02	0.07
W/Wc for estimated damping	0.01	0.04
Estimated log Decrement	0.04	0.04
Tube natural frequency <b>cycle/s</b>	384.18	384.18
Natural frequency method	Exact Solution	Exact Solution
Dominant span		
Tube effective mass <b>kg/m</b>	1.12	1.12

	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>		
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		
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Note:  $W/W_c$  = ratio of actual shellside flowrate to critical flowrate for onset of fluid-elastic instability






Tube material density	kg/m <sup>3</sup>	7841.74
Tube axial stress	N/mm <sup>2</sup>	10.13
Tube material Young's Modulus	N/mm <sup>2</sup>	203646.1
U-bend longest unsupported length	mm	

  Gachsaran Polymer Industries Company PIDMCO	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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Resonance Analysis (HTFS)

Shell number: Shell 1  
Resonance Analysis






<b>Vibration tube number</b>		1	1	1	2
<b>Vibration tube location</b>		Inlet row, centre	Inlet row, centre	Inlet row, centre	Outer window, bottom
<b>Location along tube</b>		Inlet	Midspace	Outlet	Inlet
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	234.95	342.9	406.4	406.4
<b>Frequency ratio: Fv/Fn</b>		0.06	0.01	0.01	0.02
<b>Frequency ratio: Fv/Fa</b>		0.01	0	0	0
<b>Frequency ratio: Ft/Fn</b>		0.04	0.01	0	0.01
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	384.18	384.18	384.18	384.18
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	3566.82	3422.54	3413.24	3566.82
<b>Flow velocity</b>	<b>m/s</b>	0.9	0.14	0.1	0.32
<b>X-flow fraction</b>		1	0.55	0.55	0.55
<b>RhoV2</b>	<b>kg/(m*s2)</b>	376	9	5	49
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46

  Gachsaran Polymer Industries Company PIDMCO	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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<b>Vibration tube number</b>		2	2	4	4
<b>Vibration tube location</b>		Outer window, bottom	Outer window, bottom	Baffle overlap	Baffle overlap
<b>Location along tube</b>		Midspace	Outlet	Inlet	Midspace
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	<b>mm</b>	342.9	234.95	234.95	171.45
<b>Frequency ratio: Fv/Fn</b>		0.03	0.03	0.01	0.01
<b>Frequency ratio: Fv/Fa</b>		0	0	0	0
<b>Frequency ratio: Ft/Fn</b>		0.02	0.02	0.01	0.01
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>				
<b>Turbulent buffeting amplitude</b>	<b>mm</b>				
<b>TEMA amplitude limit</b>	<b>mm</b>				
<b>Natural freq., Fn</b>	<b>cycle/s</b>	384.18	384.18	1268.63	1268.63
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	3422.54	3413.24	3566.82	3422.54
<b>Flow velocity</b>	<b>m/s</b>	0.42	0.45	0.45	0.57
<b>X-flow fraction</b>		0.55	0.55	0.55	0.55
<b>RhoV2</b>	<b>kg/(m*s2)</b>	86	106	93	163
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46

  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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<b>Vibration tube number</b>		4	5	5	5	6
<b>Vibration tube location</b>		Baffle overlap	Bottom Row	Bottom Row	Bottom Row	Inlet row, end
<b>Location along tube</b>		Outlet	Inlet	Midspace	Outlet	Inlet
<b>Vibration problem</b>		No	No	No	No	No
<b>Span length</b>	<b>mm</b>	234.95	406.4	342.9	234.95	234.95
<b>Frequency ratio: Fv/Fn</b>		0.01	0.01	0.01	0.05	0.06
<b>Frequency ratio: Fv/Fa</b>		0	0	0	0.01	0.01
<b>Frequency ratio: Ft/Fn</b>		0.01	0	0.01	0.03	0.04
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0	0
<b>Vortex shedding amplitude</b>	<b>mm</b>					
<b>Turbulent buffeting amplitude</b>	<b>mm</b>					
<b>TEMA amplitude limit</b>	<b>mm</b>					
<b>Natural freq., Fn</b>	<b>cycle/s</b>	1268.63	384.18	384.18	384.18	384.18
<b>Acoustic freq., Fa</b>	<b>cycle/s</b>	3413.24	3566.82	3422.54	3413.24	3566.82
<b>Flow velocity</b>	<b>m/s</b>	0.41	0.11	0.14	0.82	0.9
<b>X-flow fraction</b>		0.55	0.55	0.55	1	0.55
<b>RhoV2</b>	<b>kg/(m*s2)</b>	87	5	9	344	376
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46	0.46

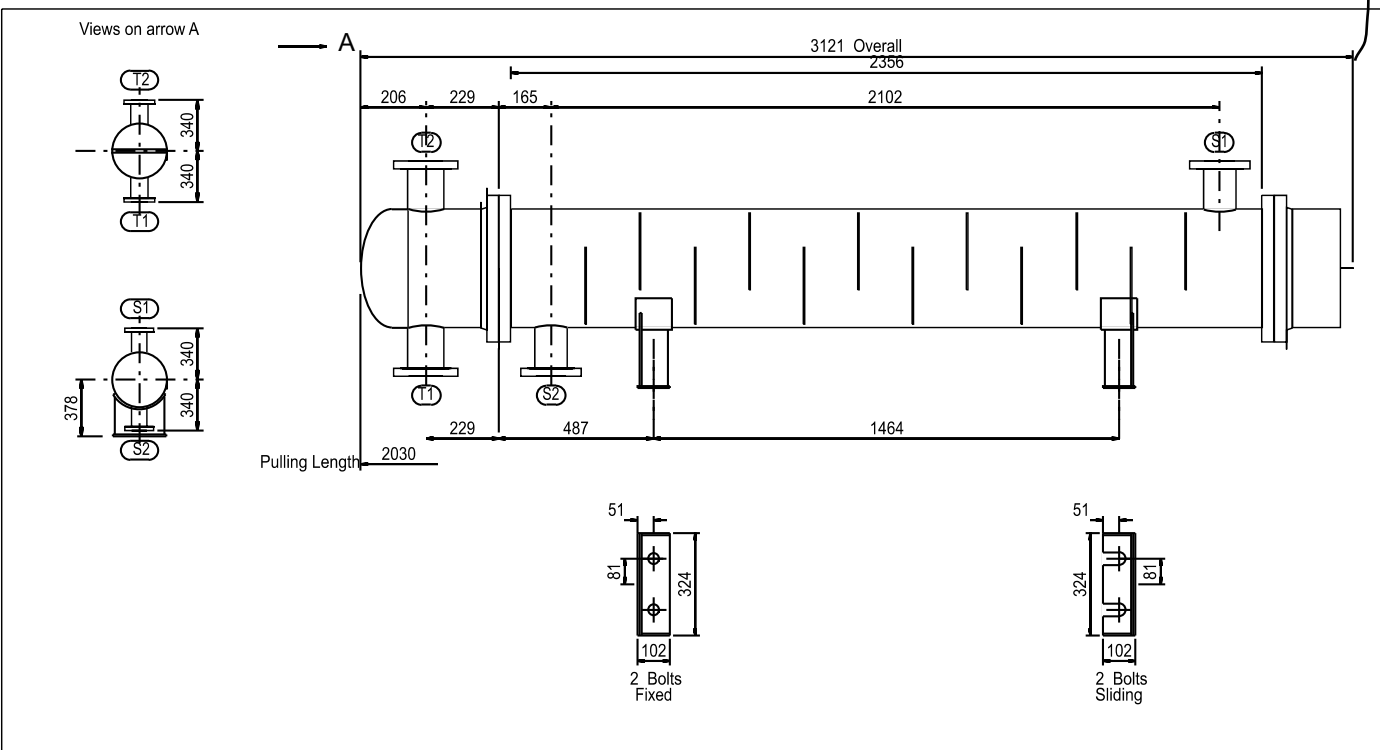
  Gachhsaran Polymer Industries Company	<b>Gachhsaran Polymer Industries Company</b> <b>HDPE Plant</b>			
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 	
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<b>Vibration tube number</b>		6	6	8	8
<b>Vibration tube location</b>		Inlet row, end	Inlet row, end	Outer window, top	Outer window, top
<b>Location along tube</b>		Midspace	Outlet	Inlet	Midspace
<b>Vibration problem</b>		No	No	No	No
<b>Span length</b>	mm	342.9	406.4	234.95	342.9
<b>Frequency ratio: Fv/Fn</b>		0.01	0.01	0.03	0.03
<b>Frequency ratio: Fv/Fa</b>		0	0	0	0
<b>Frequency ratio: Ft/Fn</b>		0.01	0	0.02	0.02
<b>Frequency ratio: Ft/Fa</b>		0	0	0	0
<b>Vortex shedding amplitude</b>	mm				
<b>Turbulent buffeting amplitude</b>	mm				
<b>TEMA amplitude limit</b>	mm				
<b>Natural freq., Fn</b>	cycle/s	384.18	384.18	384.18	384.18
<b>Acoustic freq., Fa</b>	cycle/s	3422.54	3413.24	3566.82	3422.54
<b>Flow velocity</b>	m/s	0.14	0.1	0.49	0.42
<b>X-flow fraction</b>		0.55	0.55	0.55	0.55
<b>RhoV2</b>	kg/(m*s2)	9	5	113	86
<b>Strouhal No.</b>		0.46	0.46	0.46	0.46

  Gachsaran Polymer Industries Company	<b>Gachsaran Polymer Industries Company</b> <b>HDPE Plant</b>		
	<b>Heat Exchangers Data Sheet</b> <b>(Condenser, Evaporator, Oil Cooler, Economizer)</b>		 
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<b>Vibration tube number</b>		8
<b>Vibration tube location</b>		Outer window, top
<b>Location along tube</b>		Outlet
<b>Vibration problem</b>		No
<b>Span length</b>	mm	406.4
<b>Frequency ratio: Fv/Fn</b>		0.02
<b>Frequency ratio: Fv/Fa</b>		0
<b>Frequency ratio: Ft/Fn</b>		0.01
<b>Frequency ratio: Ft/Fa</b>		0
<b>Vortex shedding amplitude</b>	mm	
<b>Turbulent buffeting amplitude</b>	mm	
<b>TEMA amplitude limit</b>	mm	
<b>Natural freq., Fn</b>	cycle/s	384.18
<b>Acoustic freq., Fa</b>	cycle/s	3413.24
<b>Flow velocity</b>	m/s	0.3
<b>X-flow fraction</b>		0.55
<b>RhoV2</b>	kg/(m*s2)	46
<b>Strouhal No.</b>		0.46

Setting Plan

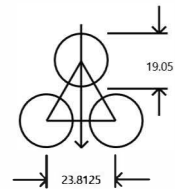
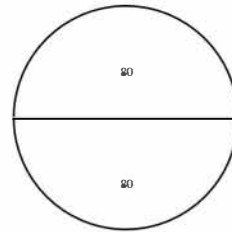
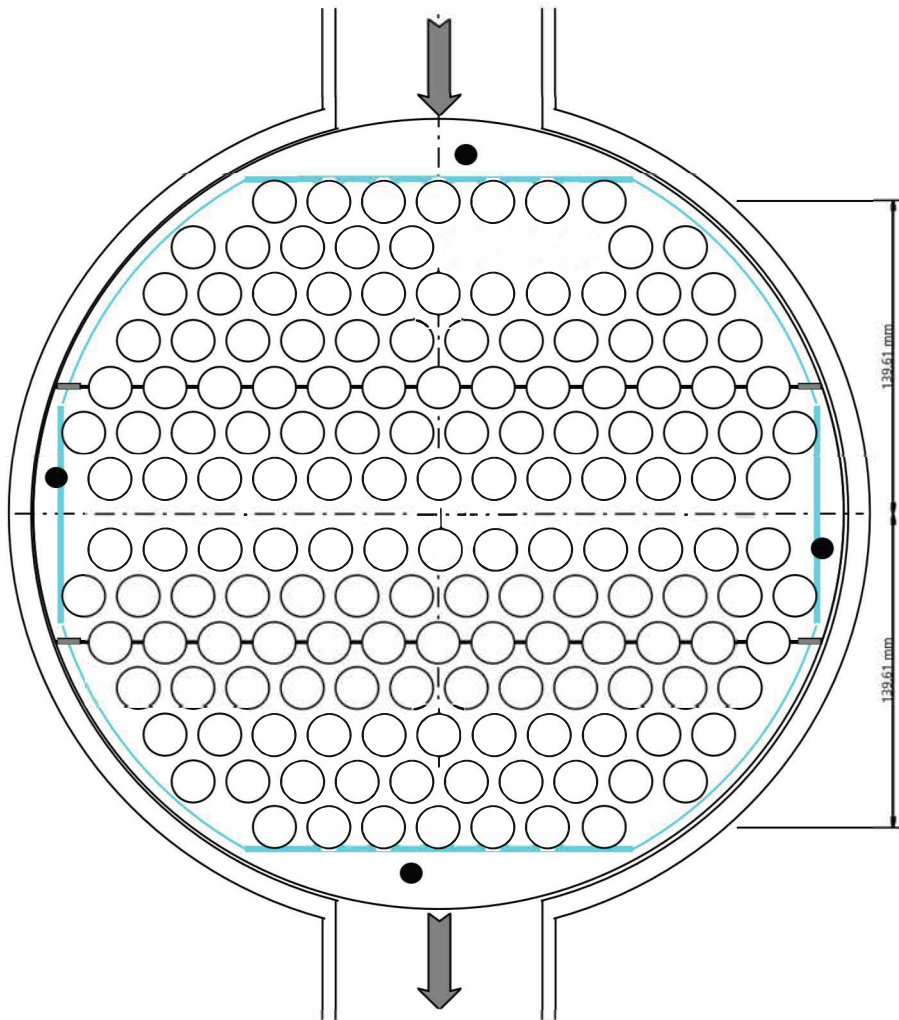


Nozzle Data					Design Data		Units	Shell	Channel	Notes:
Ref	OD	Wall	Standard	Notes	Design Pressure	bar	25	25	 <p style="text-align: center;"><b>Gachsaran Polymer Industries Company (GPIC)</b></p> <p style="text-align: center;"><b>Setting Plan</b></p> <p>ASME Section VIII Div. 2 TEMA Type: BEM Size: 358 - 2438 TEMA Class: R</p>	
S1	102 mm	5.7 mm	300 ANSI Weld neck		Design Temperature	°C	125	125		
S2	102 mm	5.7 mm	300 ANSI Weld neck		Full Vacuum					
T1	114 mm	6 mm	300 ANSI Weld neck		Corrosion Allowance	mm	3	3		
T2	114 mm	6 mm	300 ANSI Weld neck		Test Pressure	bar	32.5	32.5		
					Number of Passes		1	2		
					Radiography					
					PWHT					
					Internal Volume	m <sup>3</sup>	0.127	0.1307		
					Weight Summary					
					Empty	Flooded	Bundle			
					918 kg	1158 kg	431 kg			

Rev.	Date	Description	Dwg.	Chk.	Appd.
00	19.04.25	IFR			
01	14.07.25	IFR			

ASME Section VIII Div. 2  
TEMA Type: BEM  
Size: 358 - 2438  
TEMA Class: R

Dwg No.: VD-GPIC-MA-3029-3029-0027  
Rev:



Shell inside diameter	mm	355.6
Front head inside diameter	mm	355.6
Outer tube limit	mm	342.9
Tube number (calcs.)		160
Tube number (layout)		160
Tube length	mm	2438.4
Tube O.D.	mm	19.05
Tube pitch	mm	23.8125
Tube pattern		30
Tube passes		2
Tie rod number		4
Tie rod diameter	mm	9.55
Sealing strips (pairs)		2
Baffle type		Single segmental
Centre to outer baffle cut	mm	57.1194
Centre to inner baffle cut		
Impingement protection		None
Shell Side Inlet Nozzle Inside Diameter	mm	90.1192
Shell Side Outlet Nozzle Inside Diameter	mm	90.1192

Notes:

Date: Rev No:

Scale:

Rev.	Date:	Description	Dwg.	Chk.	Appd.	ASME Code Sec VIII Div 1	TEMA Type:	Tube Layout	Dwg No.: ULT003-00402A1-Econo	Rev mize

Size:  
TEMA Class: R - refinery service

Rev  
mize