




**DEHDASHT PETROCHEMICAL INDUSTRY COMPANY**  
**DEHDASHT HIGH DENSITY POLYETHYLENE PROJECT**



<b>Contract No.: DPIC/98-12</b>	<b>DOCUMENT TITLE: Thermal Calculation for Heat Exchangers</b>	<b>POI: IFA</b>	<b>Rev.: D3</b>
	<b>DOCUMENT No: DPIC9812-000-VD-1002-ME-CLN-0032</b>	<b>Sheet 1 of 3</b>	

## Thermal Calculation for Heat Exchangers

PURCHASER'S COMMENT/APPROVAL STATUS						Purchaser: NARGAN
1	AP: Approved (Released for Manufacturing)					
2	AN: Approved With Minor Comments (Fabrication may Proceed)					
3	NF: Approved With Comments (Fabrication not Proceed)					
4	RJ: Rejected					Item No. (Tag No.): PK-6101
5	NR: Not be Returned					
Date: XX.XX.XX		Signature:				Vendor Doc. No.: DPIC9812-000-VD-1002-ME-CLN-0032-D3
D3	27-Jan-22	IFA	R.GOUDARZI	DR.A.NEJATI	DR.A.NEJATI	
D2	24-Dec-21	IFA	R.GOUDARZI	DR.A.NEJATI	DR.A.NEJATI	
D1	02-Dec-21	IFA	R.GOUDARZI	DR.A.NEJATI	DR.A.NEJATI	
D0	30-Oct-21	IFA	R.GOUDARZI	DR.A.NEJATI	DR.A.NEJATI	
<b>REV.</b>	<b>DATE ISSUE</b>	<b>Purpose of Issue</b>	<b>PREPARED</b>	<b>CHECKED</b>	<b>APPROVED</b>	



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**Sheet 2 of 3**

**TABULATION OF REVISED PAGES**

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**PURPOSE:**

The purpose of this document is to calculate Heat exchangers.

Thermal calculation is done by “HTRI V.6”.

**ATTACHMENTS:**

Thermal calculation sheets for heat exchangers as below:

- 1- E-6101 (Evaporator)
- 2- E-PK6101-1A/B (Oil Cooler)
- 3- E-PK6101-2 (Condenser)
- 4- E-PK6101-3 (Economizer)



### HEAT EXCHANGER RATING DATA SHEET

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV. D3
Service of Unit	EVAPORATOR	Item No.	E-6101	
Type	BKU	Orientation	Horizontal	
Connected In	1 Parallel		1 Series	
Surf/Unit (Gross/Eff)	478.26 / 467.96 m <sup>2</sup>	Shell/Unit	1	
Surf/Shell (Gross/Eff)	478.26 / 467.96 m <sup>2</sup>			

#### PERFORMANCE OF ONE UNIT

Fluid Allocation	Shell Side		Tube Side			
Fluid Name	PROPYLENE		HEXANE			
Fluid Quantity, Total	19500.0		748000			
Vapor (In/Out)	wt%	24.0	100.0	0.0	0.0	
Liquid	wt%	76.0	0.0	100.0	100.0	
Temperature (In/Out)	C	-23.98	-23.98	-16.00	-20.27	
Density	kg/m <sup>3</sup>	5.7800	V/L 578.8	5.7800	703.25	706.94
Viscosity	cP	0.0073	V/L 0.1408	0.0073	0.4872	0.5147
Specific Heat	kJ/kg-C	1.4050	V/L 2.214	1.4050	1.9060	1.8875
Thermal Conductivity	W/m-K	0.0127	V/L 0.1276	0.0127	0.1310	0.1325
Critical Pressure	bar					
Inlet Pressure	bar	2.620		6.914		
Velocity	m/s			0.37	2.36	
Pressure Drop, Allow/Calc	bar	0.100	5.441e-3	0.500	0.438	
Average Film Coefficient	W/m <sup>2</sup> -K	1901.08		2630.35		
Fouling Resistance (min)	m <sup>2</sup> -K/W	0.000170		0.000090		
Heat Exchanged	1688. kW	MTD (Corrected)	5.6 C	Overdesign	9.29 %	
Transfer Rate, Service	647.54 W/m <sup>2</sup> -K	Calculated	707.73 W/m <sup>2</sup> -K	Clean	896.16 W/m <sup>2</sup> -K	

#### CONSTRUCTION OF ONE SHELL

#### Sketch (Bundle/Nozzle Orientation)

	Shell Side	Tube Side		
Design Pressure	barG	23.0 + F.V.		23.0
Design Temperature	C	-45.0 / 135.0		-45.0 / 135.0
No Passes per Shell		1		2
Flow Direction		Upward		Downward
Connections	In in	2 @ 8		1 @ 20
Size & Rating	Out in	2 @ 8	1 @ 20	
	Liq. Out mm	@	@	

Tube No.	1740	OD	19.050 mm	Thk(Avg)	2.769 mm	Length	4200. mm	Pitch	24.000 mm	Layout	90
Tube Type	Plain		Material	CARBON STEEL			Pairs seal strips	0			
Shell ID	1200.00 mm		Kettle ID	1656.09 mm			Passlane Seal Rod No.	0			
Cross Baffle Type	SUPPORT		%Cut (Diam)				Impingement Plate	None			
Spacing(c/c)	820.222 mm		Inlet	mm			No. of Crosspasses	1			
Rho-V2-Inlet Nozzle	301.62 kg/m-s <sup>2</sup>		Shell Entrance	189.05			Shell Exit	13.71		kg/m-s <sup>2</sup>	
	Bundle Entrance						Bundle Exit	kg/m-s <sup>2</sup>			
Weight/Shell	18895.9		Filled with Water	28951.8			Bundle	9559.24 kg			

Notes: Supports/baffle space = 4.	Thermal Resistance, %	Velocities, m/s	Flow Fractions			
	Shell	37.23	Shellside	0.37	A	0.000
	Tube	37.93	Tubeside	2.36	B	1.000
	Fouling	21.03	Crossflow	0.28	C	0.000
	Metal	3.81	Window	0.00	E	0.000
					F	0.000



**HEAT EXCHANGER RATING DATA SHEET**

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV.	D2
Service of Unit	OIL COOLER	Item No.	E-PK6101-1A/B		
Type	BEM	Orientation	Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	29.80 / 29.24 m <sup>2</sup>	Shell/Unit	1	Surf/Shell (Gross/Eff)	29.80 / 29.24 m <sup>2</sup>

**PERFORMANCE OF ONE UNIT**

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		OIL		JACKETED WATER	
Fluid Quantity, Total		12586.0		22395.6	
Vapor (In/Out)	wt%	0.0	0.0	0.0	0.0
Liquid	wt%	100.0	100.0	100.0	100.0
Temperature (In/Out)	C	80.30	50.00	37.00	45.00
Density	kg/m <sup>3</sup>	873.29	886.00	993.59	990.48
Viscosity	cP	1.6365	2.1900	0.6914	0.5960
Specific Heat	kJ/kg-C	2.0871	1.8530	4.1773	4.1774
Thermal Conductivity	W/m-K	0.1500	0.1500	0.6252	0.6352
Critical Pressure	bar				
Inlet Pressure	bar	19.900		6.914	
Velocity	m/s	0.18		0.79	
Pressure Drop, Allow/Calc	bar	0.200	0.024	1.000	0.144
Average Film Coefficient	W/m <sup>2</sup> -K	604.80		4882.14	
Fouling Resistance (min)	m <sup>2</sup> -K/W	0.000170		0.000200	
Heat Exchanged	208. kW	MTD (Corrected)	20.1 C	Overdesign	18.49 %
Transfer Rate, Service	353.96 W/m <sup>2</sup> -K	Calculated	419.40 W/m <sup>2</sup> -K	Clean	510.93 W/m <sup>2</sup> -K

**CONSTRUCTION OF ONE SHELL**

**Sketch (Bundle/Nozzle Orientation)**

		Shell Side	Tube Side	
Design Pressure	barG	25.0	25.0	
Design Temperature	C	120.00	190.00	
No Passes per Shell		1	4	
Flow Direction		Upward	Upward	
Connections	In in	1 @ 3	1 @ 3	
	Out in	1 @ 3	1 @ 3	
	Rating Liq. Out mm	@	@	

Tube No.	166	OD	19.050 mm	Thk(Avg)	2.108 mm	Length	3000. mm	Pitch	24.000 mm	Layout	30
Tube Type	Plain	Material	CARBON STEEL		Pairs seal strips	1					
Shell ID	381.001 mm	Kettle ID	mm		Passlane Seal Rod No.	3					
Cross Baffle Type	PERPEND. SINGLE-SEG.	%Cut (Diam)	30.00		Impingement Plate	None					
Spacing(c/c)	200.000 mm	Inlet	325.001 mm	No. of Crosspasses	13						
Rho-V2-Inlet Nozzle	615.27 kg/m-s <sup>2</sup>	Shell Entrance	428.77	Shell Exit	422.62	kg/m-s <sup>2</sup>					
		Bundle Entrance	69.96	Bundle Exit	41.59	kg/m-s <sup>2</sup>					
Weight/Shell	1111.57	Filled with Water	1493.53	Bundle	496.63 kg						

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions
	Shell 69.35	Shellside 0.18	A 0.074
	Tube 11.03	Tubeside 0.79	B 0.551
	Fouling 17.91	Crossflow 0.23	C 0.071
	Metal 1.71	Window 0.22	E 0.129
			F 0.175



### HEAT EXCHANGER RATING DATA SHEET

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV. D3
Service of Unit	CONDENSER	Item No.	E-PK6101-2	
Type	BEM	Orientation	Horizontal	
Surf/Unit (Gross/Eff)	539.22 / 521.12 m2	Shell/Unit	1	Surf/Shell (Gross/Eff) 539.22 / 521.12 m2

#### PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPYLENE		JACKETED WATER	
Fluid Quantity, Total		26500.0		289043	
Vapor (In/Out)	wt%	100.0	0.0	0.0	0.0
Liquid	wt%	0.0	100.0	100.0	100.0
Temperature (In/Out)	C	80.30	48.40	37.00	45.00
Density	kg/m3	35.722	466.87	993.59	990.48
Viscosity	cP	0.0111	0.0668	0.6914	0.5960
Specific Heat	kJ/kg-C	2.2644	3.2608	4.1773	4.1774
Thermal Conductivity	W/m-K	0.0267	0.0902	0.6252	0.6352
Critical Pressure		bar		bar	
Inlet Pressure		19.900		6.914	
Velocity		m/s		m/s	
		0.59		1.01	
Pressure Drop, Allow/Calc		bar		bar	
		0.100 / 0.018		1.000 / 0.267	
Average Film Coefficient		W/m2-K		W/m2-K	
		1283.36		5642.08	
Fouling Resistance (min)		m2-K/W		m2-K/W	
		0.000170		0.000200	
Heat Exchanged		2627. kW		MTD (Corrected) 9.7 C	
Transfer Rate, Service		529.86 W/m2-K		Calculated 678.11 W/m2-K	
				Clean 954.60 W/m2-K	
Overdesign				27.98 %	

#### CONSTRUCTION OF ONE SHELL

#### Sketch (Bundle/Nozzle Orientation)

		Shell Side	Tube Side
Design Pressure		23.0 + F.V.	23.0
Design Temperature		-45.0 / 135.0	190.00
No Passes per Shell		1	4
Flow Direction		Downward	Upward
Connections	In	1 @ 12	1 @ 12
	Out	1 @ 8	1 @ 12
	Rating	@	@

Tube No.	1802	OD	19.050 mm	Thk(Avg)	2.108 mm	Length	5000. mm	Pitch	24.000 mm	Layout	60
Tube Type	Plain		Material	CARBON STEEL		Pairs seal strips	1				
Shell ID	1180.00 mm		Kettle ID	mm		Passlane Seal Rod No.	21				
Cross Baffle Type	PARALLEL SINGLE-SEG.		%Cut (Diam)	35.00		Impingement Plate	Circular plate				
Spacing(c/c)	500.000 mm		Inlet	854.001 mm		No. of Crosspasses	9				
Rho-V2-Inlet Nozzle	262.35 kg/m-s2		Shell Entrance	346.94		Shell Exit	22.16		kg/m-s2		
			Bundle Entrance	131.60		Bundle Exit	18.48		kg/m-s2		
Weight/Shell	17846.3		Filled with Water	24472.1		Bundle	9249.03 kg				

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions
	Shell	52.84	Shellside 0.59 A 0.114
	Tube	15.43	Tubeside 1.01 B 0.545
	Fouling	28.96	Crossflow 0.70 C 0.039
	Metal	2.76	Window 0.59 E 0.139
			F 0.162



**HEAT EXCHANGER RATING DATA SHEET**

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV.	D3
Service of Unit	ECONOMIZER	Item No.	E-PK6101-3		
Type	BEM	Orientation	Horizontal	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)	115.39 / 113.79 m2	Shell/Unit	1	Surf/Shell (Gross/Eff)	115.39 / 113.79 m2

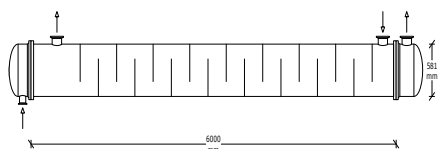
**PERFORMANCE OF ONE UNIT**

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPYLENE		PROPYLENE	
Fluid Quantity, Total	kg/hr	19500.0		7002.45	
Vapor (In/Out)	wt%	0.0	0.0	29.0	100.0
Liquid	wt%	100.0	100.0	71.0	0.0
Temperature (In/Out)	C	48.40	16.00	12.37	15.00
Density	kg/m3	461.73	520.93	17.360 V/L	526.76
Viscosity	cP	0.0599	0.0894	0.0087 V/L	0.0933
Specific Heat	kJ/kg-C	3.3267	2.5839	1.6500 V/L	2.578
Thermal Conductivity	W/m-K	0.0898	0.1061	0.0162 V/L	0.1081
Critical Pressure	bar				
Inlet Pressure	bar	19.900		8.300	
Velocity	m/s		0.21		3.39
Pressure Drop, Allow/Calc	bar	0.200	0.019	0.100	0.048
Average Film Coefficient	W/m2-K	937.52		934.72	
Fouling Resistance (min)	m2-K/W	0.000170		0.000170	
Heat Exchanged	506. kW	MTD (Corrected)	14.1 C	Overdesign	10.61 %
Transfer Rate, Service	314.50 W/m2-K	Calculated	347.86 W/m2-K	Clean	402.08 W/m2-K

**CONSTRUCTION OF ONE SHELL**

**Sketch (Bundle/Nozzle Orientation)**

		Shell Side	Tube Side
Design Pressure	barG	23.0	23.0 + F.V.
Design Temperature	C	-45.0 / 135.0	-45.0 / 135.0
No Passes per Shell		1	3
Flow Direction			Upward
Connections	In in	1 @ 6	1 @ 4
	Out in	1 @ 6	1 @ 6
	Rating Liq. Out mm	@	@



Tube No.	241	OD	25.400 mm	Thk(Avg)	2.769 mm	Length	6000. mm	Pitch	32.000 mm	Layout	30
Tube Type	Plain	Material	CARBON STEEL	Pairs seal strips	1						
Shell ID	581.001 mm	Kettle ID	mm	Passlane Seal Rod No.	0						
Cross Baffle Type	PERPEND. SINGLE-SEG.	%Cut (Diam)	28.50	Impingement Plate	None						
Spacing(c/c)	300.000 mm	Inlet	350.000 mm	No. of Crosspasses	18						
Rho-V2-Inlet Nozzle	182.91 kg/m-s2	Shell Entrance	751.84	Shell Exit	666.39 kg/m-s2						
		Bundle Entrance	247.02	Bundle Exit	45.60 kg/m-s2						
Weight/Shell	4228.95	Filled with Water	5845.51	Bundle	2416.66 kg						

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions
	Shell 37.10	Shellside 0.21	A 0.175
	Tube 47.59	Tubeside 3.39	B 0.632
	Fouling 13.49	Crossflow 0.29	C 0.051
	Metal 1.82	Window 0.30	E 0.142
			F 0.000