




**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.: D2</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-D2
						
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	
REV.	DATE ISSUE	Purpose of Issue	PREPARED	CHECKED	APPROVED	



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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 “ASPEN EXCHANGER DESIGN AND RATING V11”.

**ATTACHMENTS:**

Thermal calculation sheets for heat exchangers as below:

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



### HEAT EXCHANGER RATING DATA SHEET

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV. D2
Type	BKU	Orientation	Horizontal	Connected In 1 Parallel 1 Series
Surf/Unit (Gross/Eff)	478.25 / 467.95 m2	Shell/Unit	1	Surf/Shell (Gross/Eff) 478.25 / 467.95 m2

#### PERFORMANCE OF ONE UNIT

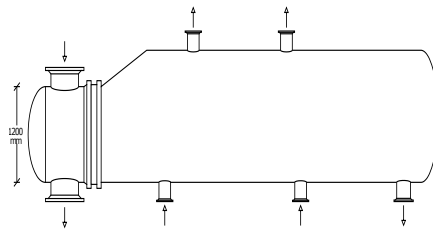
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		PROPYLENE		HEXANE	
Fluid Quantity, Total	kg/hr	19500.0		748000	
Vapor (In/Out)	wt%	24.0	100.0	0.0	0.0
Liquid	wt%	76.0	0.0	100.0	100.0
Temperature (In/Out)	C	-23.98	-23.98	-16.00	-20.27
Density	kg/m3	5.7800 V/L	578.8	5.7800	703.25
Viscosity	cP	0.0073 V/L	0.1408	0.0073	0.4872
Specific Heat	kJ/kg-C	1.4050 V/L	2.214	1.4050	1.9060
Thermal Conductivity	W/m-K	0.0127 V/L	0.1275	0.0127	0.1309
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/m2-K	1900.65		2629.72	
Fouling Resistance (min)	m2-K/W	0.000170		0.000090	

Heat Exchanged	1688. kW	MTD (Corrected)	5.6 C	Overdesign	9.29 %
Transfer Rate, Service	647.45 W/m2-K	Calculated	707.61 W/m2-K	Clean	895.96 W/m2-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	-45/125.0	-45/125.0
No Passes per Shell		1	2
Flow Direction		Upward	Downward
Connections	In in	2 @ 8	1 @ 20
	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)	820.213	mm	Inlet	mm		No. of Crosspasses	1				
Rho-V2-Inlet Nozzle	301.61 kg/m-s2		Shell Entrance	189.05		Shell Exit	13.71	kg/m-s2			
			Bundle Entrance			Bundle Exit	kg/m-s2				
Weight/Shell	18895.7		Filled with Water	28951.6		Bundle	9559.12 kg				

Notes: Supports/baffle space = 4.		Thermal Resistance, %	Velocities, m/s	Flow Fractions	
	Shell	37.23	Shellside	0.37	A 0.000
	Tube	37.94	Tubeside	2.36	B 1.000
	Fouling	21.02	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	kg/hr	12672.0		22548.6	
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	21.900		6.914	
Velocity	m/s		0.18		0.79
Pressure Drop, Allow/Calc	bar	0.200	0.024	1.000	0.146
Average Film Coefficient	W/m <sup>2</sup> -K	607.19		4908.65	
Fouling Resistance (min)	m <sup>2</sup> -K/W	0.000170		0.000200	
Heat Exchanged	209. kW	MTD (Corrected)	20.1 C	Overdesign	18.08 %
Transfer Rate, Service	356.38 W/m <sup>2</sup> -K	Calculated	420.80 W/m <sup>2</sup> -K	Clean	513.01 W/m <sup>2</sup> -K

**CONSTRUCTION OF ONE SHELL**

**Sketch (Bundle/Nozzle Orientation)**

		Shell Side	Tube Side	
Design Pressure	barG	25.000	25.000	
Design Temperature	C	120.00	190.00	
No Passes per Shell		1	4	
Flow Direction		Upward	Upward	
Connections	In in	1 @ 3	1 @ 3	
	Size & 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	371.752	mm	No. of Crosspasses	13				
Rho-V <sup>2</sup> -Inlet Nozzle	623.71 kg/m-s <sup>2</sup>		Shell Entrance	434.65		Shell Exit	428.41		kg/m-s <sup>2</sup>		
			Bundle Entrance	54.21		Bundle Exit	53.43		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 69.30	Shellside 0.18	A 0.074
	Tube 11.01	Tubeside 0.79	B 0.551
	Fouling 17.97	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. D2
Service of Unit	CONDENSER	Item No.	E-PK6101-2	
Type	BEM	Orientation	Horizontal	
Connected In	1 Parallel		1 Series	
Surf/Unit (Gross/Eff)	539.22 / 521.12 m <sup>2</sup>	Shell/Unit	1	
		Surf/Shell (Gross/Eff)	539.22 / 521.12 m <sup>2</sup>	

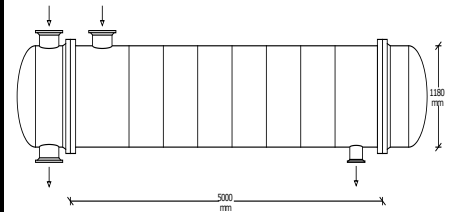
#### PERFORMANCE OF ONE UNIT

Fluid Allocation	Shell Side		Tube Side	
Fluid Name	PROPYLENE		JACKETED WATER	
Fluid Quantity, Total	kg/hr	27623.0		289043
Vapor (In/Out)	wt%	100.0	0.0	0.0
Liquid	wt%	0.0	100.0	100.0
Temperature (In/Out)	C	80.30	48.33	37.00
Density	kg/m <sup>3</sup>	35.806	467.05	993.59
Viscosity	cP	0.0112	0.0668	0.6914
Specific Heat	kJ/kg-C	2.2660	3.2592	4.1773
Thermal Conductivity	W/m-K	0.0267	0.0902	0.6252
Critical Pressure	bar			
Inlet Pressure	bar	19.937		6.914
Velocity	m/s		0.63	1.01
Pressure Drop, Allow/Calc	bar	0.100	0.017	1.000
Average Film Coefficient	W/m <sup>2</sup> -K	1284.73		5641.46
Fouling Resistance (min)	m <sup>2</sup> -K/W	0.000200		0.000200
Heat Exchanged	2682. kW	MTD (Corrected)	9.8 C	
		Overdesign	26.63 %	
Transfer Rate, Service	525.10 W/m <sup>2</sup> -K	Calculated	664.93 W/m <sup>2</sup> -K	
		Clean	955.33 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	125.00	190.00
No Passes per Shell		1	4
Flow Direction		Downward	Downward
Connections	In	in	1 @ 12
	Out	in	1 @ 12
	Rating	Liq. Out mm	@



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)	550.000	mm	Inlet	853.686	mm	No. of Crosspasses	8				
Rho-V <sup>2</sup> -Inlet Nozzle	284.39 kg/m-s <sup>2</sup>		Shell Entrance	376.09		Shell Exit	24.06	kg/m-s <sup>2</sup>			
			Bundle Entrance	142.77		Bundle Exit	10.48	kg/m-s <sup>2</sup>			
Weight/Shell	17792.0		Filled with Water	24424.7		Bundle	9194.71 kg				

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions
	Shell	51.76	Shellside 0.63 A 0.107
	Tube	15.14	Tubeside 1.01 B 0.556
	Fouling	30.40	Crossflow 0.74 C 0.040
	Metal	2.71	Window 0.69 E 0.130
			F 0.167



### HEAT EXCHANGER RATING DATA SHEET

CUSTOMER	DEHDASHT PETROCHEMICAL	PACKAGE	PK-6101	REV. D2
Service of Unit	ECONOMIZER	Item No.	E-PK6101-3	
Type	BEM	Orientation	Horizontal	
Surf/Unit (Gross/Eff)	115.39 / 113.93 m <sup>2</sup>	Shell/Unit	1	Surf/Shell (Gross/Eff) 115.39 / 113.93 m <sup>2</sup>
Connected In	1 Parallel 1 Series			

#### PERFORMANCE OF ONE UNIT

Fluid Allocation	Shell Side		Tube Side	
Fluid Name	PROPYLENE		PROPYLENE	
Fluid Quantity, Total	kg/hr	19500.0		7038.39
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	48.55	16.00	12.37 / 15.00
Density	kg/m <sup>3</sup>	461.40	520.94	17.360 V/L / 526.76 / 17.110
Viscosity	cP	0.0598	0.0894	0.0087 V/L / 0.0933 / 0.0087
Specific Heat	kJ/kg-C	3.3320	2.5836	1.6500 V/L / 2.578 / 1.6550
Thermal Conductivity	W/m-K	0.0897	0.1061	0.0162 V/L / 0.1081 / 0.0165
Critical Pressure	bar			
Inlet Pressure	bar	20.020		8.300
Velocity	m/s		0.21	
Pressure Drop, Allow/Calc	bar	0.200	0.020	0.100 / 0.049
Average Film Coefficient	W/m <sup>2</sup> -K	967.84		942.07
Fouling Resistance (min)	m <sup>2</sup> -K/W	0.000170		0.000170
Heat Exchanged	508. kW	MTD (Corrected)	14.2 C	Overdesign 12.28 %
Transfer Rate, Service	314.62 W/m <sup>2</sup> -K	Calculated	353.27 W/m <sup>2</sup> -K	Clean 409.33 W/m <sup>2</sup> -K

#### CONSTRUCTION OF ONE SHELL

#### Sketch (Bundle/Nozzle Orientation)

	Shell Side	Tube Side	
Design Pressure	barG	23.0	23+F.V
Design Temperature	C	125	-45/125
No Passes per Shell		1	3
Flow Direction		Upward	Upward
Connections	In	in	1 @ 6
	Out	in	1 @ 6
	Liq. Out	mm	@
Size & Rating			@

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	412.257	mm	No. of Crosspasses	19				
Rho-V <sup>2</sup> -Inlet Nozzle	183.04	kg/m-s <sup>2</sup>	Shell Entrance	752.37	kg/m-s <sup>2</sup>	Shell Exit	666.38	kg/m-s <sup>2</sup>			
			Bundle Entrance	178.17	kg/m-s <sup>2</sup>	Bundle Exit	157.81	kg/m-s <sup>2</sup>			
Weight/Shell	4178.64	Filled with Water	5795.66	Bundle	2412.12 kg						

Notes:	Thermal Resistance, %	Velocities, m/s	Flow Fractions
	Shell	36.50	Shellside 0.21 A 0.175
	Tube	47.96	Tubeside 3.42 B 0.632
	Fouling	13.70	Crossflow 0.29 C 0.051
	Metal	1.85	Window 0.30 E 0.142
			F 0.000