PPI / NARGAN	**DEHDASHT PETROCHEMICAL INDUSTRY COMPANY** **DEHDASHT HIGH DENSITY POLYETHYLENE PROJECT**	شرکت صنایع پتروشیمی خلیج فارس Persian Gulf Petrochemical Industries Co PGPIC شرکت صنایع پتروشیمی دهدشت (سهامی عام)
Contract No.: DPIC/98-12	**DOCUMENT TITLE: Thermal Calculation for Heat Exchangers**	**POI: IFA** / **Rev.: D2**
	DOCUMENT No: DPIC9812-000-VD-1002-ME-CLN-0032	**Sheet 1 of 3**

Refer to item C.5 of TCL please submit simulation file of refrigeration cycle and HTRI thermal files.

Please check the comments reply on revision D1 and implement the unclosed ones.

GENERAL COMMENT:
1- As per Doc. No. DPC-PR-CRT-0001 equipment design criteria (MR attachment) 10% safety overdesign shall be considered on design case for heat exchanger sizing.
2- MDMT=-45C to be considered for all equipment.
3- Please recheck design condition of all equipment. Design condition of each eq shall be in conjunction of downstream and upstream eq.

Thermal Calculation for H

PURCHASER'S COMMENT/APPROVAL STATUS		Purchaser: NARGAN
1	AP: Approved (Released for Manufacturing)	
X	AN: Approved With Minor Comments (Fabrication may Proceed)	Requisition No.: DPIC98-12-001-000-ME-MR-4150-0001-D1
3	NF: Approved With Comments (Fabrication not Proceed)	
4	RJ: Rejected	Item No. (Tag No.): PK-6101
5	NR: Not be Returned	
Date: 09.01.2022	Signature: A.AB	Vendor Doc. No.: DPIC9812-000-VD-1002-ME-CLN-0032-D2

REV.	DATE ISSUE	Purpose of Issue	PREPARED	CHECKED	APPROVED
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

KASRAVAND Engineering & Construction

TABULATION OF REVISED PAGES

Page	Rev-D0	Rev-D1	Rev-D2	Rev-D3	Rev-D4
1	x	x	x		
2	x	x	x		
3	x	x	x		
4					
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36					
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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)

BASE ON YOUR PREVIOUSE COMMENT FLOW CHANGED TO 748000 KG/H.
CHANGING THE FLOWRATE AGAIN IS NOT ACCEPTABLE BEACUSE ALL OF PACKAGE CAPACITY CHANGED AGAIN.
EVAPORATOR SIZE IS OK AND CAN HANDLE YOUR DESIGN FLOW. THIS IS RESPONSIBILITY OF PACKAGE DESIGNER.

HEAT EXCHANGER RATING DATA SHEET

CAL PACKAGE PK-6101 REV. D2

ation Horizontal Connected In 1 Parallel 1 Series

Shell/U 5 / 467.95 m2

PERFOR

This flowrate causes less duty than design duty. Flowrate shall be corrected.

		Shell Side		Tube Side	
		YLENE		HEXANE	
Fluid Quantity, Total	kg/hr	19500.0		748000	
Vapor (In/Out)	wt%	24.0	100.0	0.0	0.0
		76.0	0.0	100.0	100.0
		-23.98	-23.98	-16.00	-20.27
		5.7800 V/L 578.8	5.7800	703.25	706.94
		0.0073 V/L 0.1408	0.0073	0.4872	0.5147
		1.4050 V/L 2.214	1.4050	1.9060	1.8875
		0.0127 V/L 0.1275	0.0127	0.1309	0.1324
	bar				
Inlet Pressure	bar	2.620		6.914	
Velocity			0.37		2.36
Pressure Drop, Allow		100	5.441e-3	0.500	0.438
Average Film Coefficient	W/m2-K	1900.65		29.72	
Fouling Resistance (min)	m2-K/W	0.000170		0.000090	

Please refer to the letter which the vendor discussed about flow and the amount of duty. it is not possible to have this duty with this amount of flow.

Design duty is 1750KW.

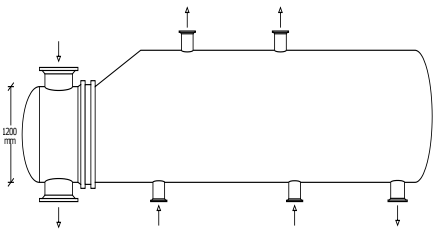
CORRECTED

-45/135

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
Size &	Out	in	2 @ 8	1 @ 20
Rating	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

The tube sheet thickness specified in the mechanical drawing. More or less of this thickness has little effect on the heat exchanger surface and ultimately the thermal calculations. Since the over design of this heat exchanger is equal to 18%,It is not clear what the purpose of leaving this comment

Based on mechanical data (Tubesheet THK) eff surface is less than 29.24m2. Please input all data for checking before print the result.

IT IS RESPONSIBILITY OF PACKAGE DESIGNER

Cooling water velocity in carbon steel tubes shall be within 1-3m/s.

Please check the Flow rate with PFD-027

CORRECTED

NOZZLES ARE FINILIZED BESED ON PIPING MODEL. LOCATION OF NOZZLE IS OK FOR THIS HEAT EXCHANGER

-45/135

For optimum performance inlet nozzle shall be located at top of shell and outlet at bottom of shell.

DESIGN TEMP. FOR OIL COOLER SHELL SIDE IS OK.

there is discrepancy between No. baffle and cross pass.

NO. OF BUFFLE IS 12 AND WE HAVE 13 CROSSPASSES. WHAT IS THE DISCREPANCY?

H TA SHEET

CHEMICAL E D2

E-PK

Orientation d In 1 Parallel 1 Series

S (Gross/Eff) 29.80 / 29.24 m2

PE

		Shell Side		Tub	
		OIL		JACKETED WATER	
Fluid Quantity, Total	kg/hr	12672.0		22	
Vapor (In/Out)	wt%	0.0	0.0	0.0	0.0
Liquid		100.0	100.0	100.0	100.0
Temper		80.30		37.00	45.00
Density		873.29		993.59	990.48
Viscosity	cP	1.6365		0.6914	0.5960
Specific Heat	kJ/kg-C	2.0871		4.1773	4.1774
	W/m-K	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		0.146
Average Film Coefficient	W/m2-K	607.19			65
	2-K/W	0.000170			200

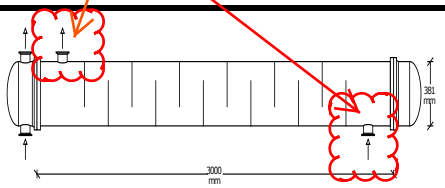
209. kW MTD (Corrected) 20.1 C 8 %

Transfer Rate Service 356.38 W/m2-K Calculated 420.80 W/m2-K /m2-K

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)

	Shell Side	Tube Side
	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 out 30

Tube Type Plain Material CARBON STEEL Pa

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 Inle Crosspasses 13

Rho-V2-Inlet Nozzle 623.71 kg/m-s2 xit 428.41 kg/m-s2

Exit 53.43 kg/m-s2

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

HTRI

HEAT

This surface is under design
Please send the thermal file for checking or increase the surface.

CUSTOMER	DEHDASHT PETROCHEMICAL		REV. D2
Service of Unit	CONDENSER	Item No.	E-PK6101-2
Type	BEM	Orientation Horizontal	Connecte AREA IS OK Series
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	kg/hr	27623.0		289043	
Vapor (In/Out)	wt%	100.0	0.0	0.0	0.0
	wt%	0.0	100.0	100.0	100.0
Temperature (In/Out)	C	80.30	48.33	37.00	45.00
Density	kg/m3	35.806	467.05	993.00	990.48
Viscosity		0.0112	0.0668	0.6914	0.5960
Specific He		2.2660	3.2592	4.1773	4.1774
Thermal Co		0.0267	0.0902		0.6352
Critical Pres					
Inlet Pressu		19.937			14
Velocity			0.63		1.01
Pressure Drop, Allow/Calc	bar	0.100	0.017		0.267
Average Film Coefficient	W/m2-K	1284.73		5641.46	
	K/W	0.000200		0.000200	

CORRECTED

Propylene fouling factor in E-6101 and E-6101-3 is considered 0.0017w/m2k Please clarify.

CORRECTED

Nozzle allocation is changed wrongly. Please revers same as previous revision.

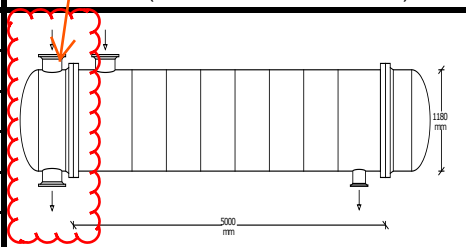
-45/135

CORRECTED

	2682. kW	MTD (Corrected) 9.8 C		Overdesign 26.63 %
Transfer Rate, Service	525.10 W/m2-K	Calculated 664.93 W/m2-K		Clean 955.33 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	125.00	190.00
No Passes per Shell			1	4
Flow Direction			Downward	Downward
Connections	In	in	1 @ 12	1 @ 12
Size &	Out	in	1 @ 8	1 @ 12
Rating	Liq. Out	mm	@	@

CORRECTED

Discrepancy with DWG.

Tube No.	1802	OD 19.050 mm	Thk(Avg) 2.108 mm		Length 5000. mm	Pitch	
Tube Type	Plain		Material CARBON STEEL			Pairs seal strips	1
Shell ID	1180.00 mm		Kettle ID	mm	CORRECTED	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-V2-Inlet Nozzle	284.39	kg/m-s2	Shell Entrance	376.09	Shell Exit	24.06	kg/m-s2
			Bundle Entrance	142.77	Bundle Exit	10.48	kg/m-s2
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	Connected In	1 Parallel	1 Series
Surf/Unit (Gross/Eff)	115.39 / 113.93 m2	Shell/Unit 1	Surf/Shell (Gross/Eff)	115.39 / 113.93 m2	

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/m3			17.360 V/L 526.76	17.110
Viscosity	cP			0.0087 V/L 0.0933	0.0087
Specific Heat	kJ/kg-C			1.6500 V/L 2.578	1.6550
Thermal Conductivity	W/m-K			0.0162 V/L 0.1081	0.0165
Critical Pressure	bar				
Inlet Pressure	bar	20.020		8.300	
Velocity	m/s		0.21		3.42
Pressure Drop, Allow/Calc	bar	0.200	0.020		0.049
Average Film C		967.84			
Fouling Resist		0.000170			

Heat Exchanged 508. kW MTD (Corrected) 14.2 C %

Trans CORRECTED 314.62 W/m2-K Calculated 353.27 W/m2-K 2-K

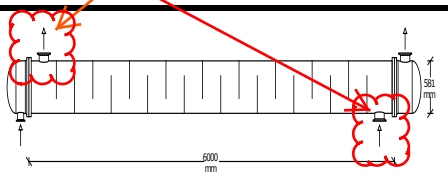
INLET NOZZLE CORRECTED BUT OUTLET NOZZLE IS IN OK POSITION

-45/135

For optimum performance inlet nozzle shall be located at top of shell and outlet at bottom of shell.

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	1 @ 4
Size &	Out	in	1 @ 6	
Rating	Liq. Out	mm	@	

SINCE THE EVAPORATION IS IN TUBE SIDE MIST FLOW IS HAPPEN NEAR THE OUTLET WHEN MOST OF THE LIQUID EVAPORATED. WE HAVE A LOT A OF EXPERIECNCE FOR SUCH A THIS TYPE OF ECONOMIZER.PLAESE DO NOT GIVE THIS COMMENT AGAIN. PLEASE BE INFORM THAT THIS IS A WARNING OF HTRI NOT A PROBLEM.

Tube No.	241 OD 25.400 mm	Thk(Avg)	2.76		0
Tube Type	Plain	Material	CAR		
Shell ID	581.001 mm	Kettle ID			
Cross Baffle Type	PERPEND. SINGLE-SEG.				
Spacing(c/c)	300.000 mm	Inlet	412.257		
Rho-V2-Inlet Nozzle	183.04 kg/m-s2				
		Bundle Entrance	178.17	Bundle Exit	157.81 kg/m-s2
Weight/Shell	4178.64	Filled with Water	5795.66	Bundle	2412.12 kg

Dry wall mist flow, film and transition boiling regime are expected for the boiling fluid.
Please resolve the problems or send the thermal file for checking.

N			ties, m/s	Flow Fractions	
			ide 0.21	A	0.175
			ide 3.42	B	0.632
			flow 0.29	C	0.051
		Metal	1.85	Window 0.30	E	0.142
					F	0.000