



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



Contract No.: DPIC/98-12

DOCUMENT TITLE: Thermal Calculation for Heat Exchangers

POI: IFA

Rev.: D0

DOCUMENT No: DPIC9812-000-VD-1002-ME-CLN-0032

Sheet 1 of 21

Exchangers shall be designed and rated by  
HTRI ver.07

محاسبات با نرم افزار HTRI VER.06 انجام شد.  
روپژن 07 دارای باگ است

## 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)



NF: Approved With Comments (Fabrication not Proceed)

4 RJ: Rejected

5 NR: Not be Returned

Requisition No.: DPIC98-12-001-000-ME-MR-4150-0001-D1

Item No. (Tag No.): PK-6101

Date: 20.11.2021

Signature:

A.AB

Vendor Doc. No.: DPIC9812-000-VD-1002-ME-CLN-0032-D0



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 21**

**TABULATION OF REVISED PAGES**

Page	Rev-D0	Rev-D1	Rev-D2	Rev-D3	Rev-D4
1	x				
2	x				
3	x				
4	x				
5	x				
6	x				
7	x				
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	<p align="center"><b>DEHDASHT PETROCHEMICAL INDUSTRY COMPANY</b></p> <p align="center"><b>DEHDASHT HIGH DENSITY POLYETHYLENE PROJECT</b></p>		
<p><b>Contract No.: DPIC/98-12</b></p>	<p><b>DOCUMENT TITLE:</b> Thermal Calculation for Heat Exchangers</p>	<p><b>POI:</b> IFA</p>	<p><b>Rev.:</b> D0</p>
	<p><b>DOCUMENT No:</b> DPIC9812-000-VD-1002-ME-CLN-0032</p>	<p align="center"><b>Sheet 3 of 21</b></p>	

#### 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)

## TEMA Sheet

## Heat Exchanger Specification

1	Company: DEHDASHT PETROCHEMICAL INDUSTRY COMPANY									
2	For : PK-6101									
3	Service of Unit: HEXANE CHILLER									
4	Item No.: E-6101									
5	Date: Rev No.: 00									
6	Size: 1150 / 1676 -4200									
7	Surf/unit(eff.) 434.4									
8										
9	Fluid allocation									
10	Fluid name									
11	Fluid quantity, Total									
12	Vapor (In/Out)									
13	Liquid									
14	Noncondensable									
15										
16	Temperature (In/Out)									
17	Bubble / Dew point									
18	Density									
19	Viscosity									
20	Molecular wt, Vap									
21	Molecular wt, NC									
22	Specific heat									
23	Thermal conductivity									
24	Latent heat									
25	Pressure (abs)									
26	Velocity (Mean/Max)									
27	Pressure drop, allow./									
28	Fouling resistance (m									
29	Heat exchanged									
30	Transfer rate, Service									
31	CONSTRUCTION OF ONE SHELL									
32	Sketch									
33	Design/Vacuum/test									
34	Design temperature									
35	Number passes per shell									
36	Corrosion allowance									
37	Connections									
38	Size/Rating									
39	Nominal									
40	Tube #: 816 U's OD: 19.05 Tks. Average 2.11 mm Length: 4200 mm Pitch: 24 mm Tube pattern: 90									
41	Tube type: Plain Insert: None #/m Material: SA-334 6 K03006									
42	Shell SA-516 70 K02700 ID 1150 OD									
43	Channel or bonnet SA-516 70 K02700									
44	Tubesheet-stationary Carbon Steel									
45	Floating head cover									
46	Baffle-cross Carbon Steel									
47	Baffle-long									
48	Supports-tube U-bend 0 Type									
49	Bypass seal									
50	Expansion joint									
51	RhoV2-Inlet nozzle 1197 Bundle entrant									
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 15166.8 Filled with water 27816.9 Bundle 7840.1 kg									
56	Remarks 10% OVER DESIGN HAS BEEN CONSIDERED IN FLOW									
57										
58										

انجام شد

اصلاح شد

based on HTRI checking file, duty is unbalance and it seems propylene flowrate shall be slightly decreased.

according to DPIC98-12-001-60 0-ME-DS-4150-6101 Mass flow of HEX in& out shall be 748,000, please revise this item

based on data sheet Hexane flowrate is 74800x1.1 kg/h Please clarify.

انجام شد

Refrigerant shall be fully vaporized in kettle.

pressure drop shall be less than allowable one. Based on data sheet allowable pressure drop is 50kpa.

Design temperature of both sides shall be saturate temperature corresponding to design pressure which is equal to 125C. Please recheck.

Please specify these item accordance with Datasheet

Please check the UC566 and PWHT attention to MDMT

Please specify according to MDS

در طراحی مکانیکی بررسی میشود

در طراحی مکانیکی بررسی میشود

Overall Su

Please specify shell thickness.

1	Size	1150	X	4200	mm	Type	BKU	Hor	Connected in	1 parallel	1 series
2	Surf/Unit (gross/eff/finned)			447.3	/	434.4	/	m²	Shells/unit	1	
3	Surf/Shell (gross/eff/finned)			447.3	/	434.4	/	m²			
4	Rating / Checking	PERFORMANCE OF ONE UNIT									
5		Shell Side				Tube Side		Heat Transfer Parameters			
6	Process Data		In	Out	In	Out	Total heat load kW 1924.5				
7	Total flow	kg/h		21196		911350	Eff. MTD/ 1 pass MTD °C 6.23 / 6.31				
8	Vapor	kg/h	4239	21188	0	0	Actual/Reqd area ratio - fouled/clean 1.07 / 1.36				
9	Liquid	kg/h	16957	8	911350	911350					
10	Noncondensable	kg/h		0		0	Coef./Resist.	W/(m²-K)	m²-K/W		
11	Cond./Evap.	kg/h		16949		0	Overall fouled	759.3	0.00132		
12	Temperature	°C	-23.98	-24.89	-16	-19.99	Overall clean	964.7	0.00104		
13	Bubble Point	°C					Tube side film	2144.8	0.00047	35.4	
14	Dew Point	°C					Tube side fouling	9052.1	0.00011	8.39	
15	Vapor mass fraction		0.2	1	0	0	Tube wall	25469	4E-05	2.98	
16	Pressure (abs)	bar	2.66	2.57278	6.914	6.56446	Outside fouling	5882.4	0.00017	12.91	
17	DeltaP allow/cal	bar	0.5	0.08722	0.26	0.34954	Outside film	1882.9	0.00053	40.32	
18	Velocity	m/s	0.57	2.01	2.55	2.54					
19	Liquid Properties						Shell Side Pressure Drop bar %				
20	Density	kg/m³	580	580.2	703.25	706.68	Inlet nozzle 0.01617 41.49				
21	Viscosity	cp	0.1422	0.1425	0.4872	0.5128	InletspaceXflow 0 0				
22	Specific heat	kJ/(kg-K)	2.207	2.206	1.906	1.89	Baffle Xflow 0.014 35.92				
23	Therm. cond.	W/(m-K)	0.1281	0.1282	0.131	0.1324	Baffle window 0 0				
24	Surface tension	N/m	0.0116	0.0117	0.0224	0.0229	Outlet spaceXflow 0 0				
25	Molecular weight		42.08	42.08	85.93	85.93	Outlet nozzle 0.0088 22.58				
26	Vapor Properties						Intermediate nozzles				
27	Density	kg/m³	5.81	5.6			Tube Side Pressure Drop bar %				
28	Viscosity	cp	0.0073	0.0073			Inlet nozzle 0.0185 5.29				
29	Specific heat	kJ/(kg-K)	1.402	1.4			Entering tubes 0.01717 4.91				
30	Therm. cond.	W/(m-K)	0.0126	0.0126			Inside tubes 0.29638 84.79				
31	Molecular weight		42.08	42.08			Exiting tubes 0.00674 1.93				
32	Two-Phase Properties						Outlet nozzle 0.01075 3.08				
33	Latent heat	kJ/kg	410	411			Intermediate nozzles				
34	Heat Transfer Parameters						Velocity / Rho*V2 m/s kg/(m-s²)				
35	Reynolds No. vapor		95762.25	478945.6			Shell nozzle inlet 6.56 1197				
36	Reynolds No. liquid		19549.12	8.8	54670.3	51943.13	Shell bundle Xflow 0.57 2.01				
37	Prandtl No. vapor		0.81	0.81			Shell baffle window				
38	Prandtl No. liquid		2.45	2.45	7.09	7.32	Shell nozzle outlet 20.75 2401				
39	Heat Load		kW		kW		Shell nozzle interm				
40	Vapor only		0		0						
41	2-Phase vapor		0		0		m/s kg/(m-s²)				
42	Latent heat		1924.5		0		Tube nozzle inlet 2.39 4009				
43	2-Phase liquid		0		0		Tubes 2.55 2.54				
44	Liquid only		0		-1924.5		Tube nozzle outlet 2.38 3989				
44	Liquid only		0		-1924.5		Tube nozzle interm				
45	Tubes					Baffles	Nozzles: (No./OD)				
46	Type			Plain	Type	Unbaffled					
47	ID/OD	mm	14.83	/	19.05	Number	0	Inlet	mm	1	/ 219.08
48	Length act/eff	cm	420	/	406.7	Cut(%d)		Outlet		1	/ 60.32
49	Tube passes		2			Cut orientation		Intermediate		1	/ 273.05
50	Tube No.		1632			Spacing: c/c	mm	Impingement protection		None	
51	Tube pattern		90			Spacing at inlet	mm				
52	Tube pitch	mm	24			Spacing at outlet	mm				
53	Insert				None						
54	Vibration problem (HTFS / TEMA)	Yes	/					RhoV2 violation			Yes

## Overall Performance

Rating / Checking		Shell Side		Tube Side	
Total mass flow rate	kg/h	21196		911350	
Vapor mass flow rate (In/Out)	kg/h	4239	21188	0	0
Liquid mass flow rate	kg/h	16957	8	911350	911350
Vapor mass fraction		0.2	1	0	0
Temperatures	°C	-23.98	-24.89	-16	-19.99
Bubble / Dew point	°C	/	/	/	/
Operating Pressures	bar	2.66	2.57278	6.914	6.56446
Film coefficient	W/(m²-K)	1882.9		2144.8	
Fouling resistance	m²-K/W	0.00017		0.00011	
Velocity (highest)	m/s	2.01		2.55	
Pressure drop (allow./calc.)	bar	0.5	0.08722	0.26	0.34954
Total heat exchanged	kW	1924.5		Unit	
Overall clean coeff. (plain/finned)	W/(m²-K)	964.7	/	BKU	2 pass 1 ser 1 par
Overall dirty coeff. (plain/finned)	W/(m²-K)	759.3	/	Shell size	1150 - 4200 mm Hor
Effective area (plain/finned)	m²	434.4	/	Tubes	Plain
Effective MTD	°C	6.23		Insert	None
Actual/Required area ratio (dirty/clean)		1.07	1.36	No.	1632 OD 19.05 Tks 2.11 mm
Vibration problem (HTFS)		Yes		Pattern	90 Pitch 24 mm
RhoV2 problem		Yes		Baffles	Unbaffled Cut(%d)
				Total cost	187805 Dollar(US)

Total M  
Errors: 1  
Input: 0  
Results  
Operati  
Notes &  
Warning

## Heat Transfer Resistance

Shell side / Fouling / Wall / Fouling / Tube side

Shell Side  Tube Side

## Resistance Distribution

Overall Coefficient / Resistance Summary			Clean	Dirty	Max Dirty
Area required (tube OD base)	m²		320.4	407.1	434.4
Area ratio: actual/required			1.36	1.07	1
Overall coefficient	W/(m²-K)		964.7	759.3	711.6
Overall resistance	m²-K/W		0.00104	0.00132	0.00141
Shell side fouling	m²-K/W		0	0.00017	0.00022
Tube side fouling	m²-K/W		0	0.00011	0.00015
<b>Resistance Distribution</b>	W/(m²-K)	m²-K/W	%	%	%
Shell side film	1882.9	0.00053	51.23	40.32	37.79
Shell side fouling	5882.4	0.00017		12.91	15.9
Tube wall	25469	4E-05	3.79	2.98	2.79
Tube side fouling *	9052.1	0.00011		8.39	10.33
Tube side film *	2144.8	0.00047	44.98	35.4	33.18

\* Based on outside surface - Area ratio: Ao/Ai = 1.28

## Shell by Shell Conditions

		Shell 1
Shell heat load	kW	1924.5
Shell inlet temperature	C	-23.98
Shell outlet temperature	C	-24.89
Tube inlet temperature	C	-16
Tube outlet temperature	C	-19.99
Shell inlet vapor fraction		0.2
Shell outlet vapor fraction		1
Tube inlet vapor fraction		0
Tube outlet vapor fraction		0
Shell inlet pressure	bar	2.66
Shell outlet pressure	bar	2.57278
Tube inlet pressure	bar	6.914
Tube outlet pressure	bar	6.56446
Shell pressure drop	bar	0.08722
Tube pressure drop	bar	0.34954
Mean shell metal temperature	C	-24.45
Mean tube metal temperature	C	-21.07
Minimum tube metal temperature	C	-21.98
Maximum tube metal temperature	C	-19.96

- 1- Shell entrance velocity exceeds critical velocity, indicating a probability of fluidelastic instability and flow-induced vibration damage.
- 2- Shell exit velocity exceeds 80% of critical velocity, indicating that fluidelastic instability and flow-induced vibration damage are possible.
- 3- the longest unsupported span of the bundle is in the U-bend region and thus prone to excessive vibration.

این گونه error ها که توسط  
نرم افزار داده شده بود بر  
طرف شد

## TEMA Sheet

Heat Exchanger Specification Sheet

ASHT PETROCHEMICAL INDUSTRY COMPANY

FOR : PK-6101

Service of Unit: Our Reference: No.:  
 Item No.: E- Your Reference: No.:  
 Date: No.:  
 Size: 330 type: BEM Horizontal : 1 parallel 1 series  
 Surf/unit(eff.) Shells/unit 1 Surf/shell(eff.) 30.5 m<sup>2</sup>

PERFORMANCE OF ONE UNIT

	Shell Side	Tube Side
Fluid allocation	OIL	COOLING WATER
Fluid name	OIL	COOLING WATER
Fluid quantity	15206 kg/h	22248 kg/h
Vapor (In)	0 kg/h	0 kg/h
Liquid	15206 kg/h	22248 kg/h
Noncondensable	0 kg/h	0 kg/h
Temperature	80.3 °C	35 °C
Bubble	50 °C	45 °C
Density	873.29 kg/m <sup>3</sup>	886.58 kg/m <sup>3</sup>
Viscosity	1.6365 cp	2.1994 cp
Molecular wt, vap		
Molecular wt, NC		
Specific heat	kJ/(kg-K)	kJ/(kg-K)
Thermal conductivity	W/(m-K)	W/(m-K)
Latent heat	kJ/kg	kJ/kg
Pressure	21.9 bar	6.5 bar
Flow velocity	0.27 m/s	0.44 m/s
Flow direction	0.1203	0.5
Fouling resistance (min)	0.00017	0.00035
Heat exchanged	445.8 kW	597.8 kW
Transfer rate, Service	445.8 kW	597.8 kW
MTD (corrected)	21.31 °C	

Sketch

Design/Vacuum/test pressure bar 25 / -1.013 / 20 / -1.013 /

Temperature /MDMT °C 120 / 65 /

Number of tubes per shell 1 2

Tube arrangement 3 3

In 3 / - 1 3 / -

Out 1 3 / - 1 3 / -

Nominal Intermediate / -

Tube #: 130 OD: 19.05 Tks. Average 1.2 mm Length: 4000 mm Pitch: mm

Tube type: Plain Insert: None Fin #: #/m

Shell SA-106 B K03006 ID 336.6 OD 355.6 mm Shell cover -

Channel or bonnet SA-106 B K03006 Tubesheet cover -

Tubesheet-stationary Carbon Steel Tubes Impingement

Floating head cover -

Baffle-cross Carbon Steel Type Single segmental Cut(%d) 26.76 mm

Baffle-long - Seal Type

Supports-tube U-bend 0 Type

Bypass seal Expanded & strength welded(App.A 'e')

Expansion joint - None

RhoV2-Inlet nozzle Bundle entrance 27 Bundle exit 26 lb/(ft-s<sup>2</sup>)

Gaskets - Shell side Tube side Flat Metal Jacket Fibe

Floating head -

Code requirements ASME Code Sec VIII Div 1 TEMA class R - refinery service

Weight/Shell 979.3 Filled with water 1326.6 Bundle 382 kg

Remarks 20% OVER DESIGN HAS BEEN CONSIDERED IN OIL FLOW RATE

Tube nozzle shall be located at top of channel.

shell inlet shall be located at bottom.

up to 1-bar is accepted.

6.914 bara based on utility and site condition.

Refer to utility and site condition, Jacketed water temperature is 37-47C.

according to DPIC-12-001/000-4150-ME-PFD-027 there is discrepancy at the shell side.28 m<sup>3</sup>/hr = 27846 kg/h

according to DPIC-12-001/000-4150-ME-PFD-027 there is discrepancy at the shell side.240\*60/1000=12672 kg/h

please specify the density for PFD to controlling this value

CW velocity is too low shall be increased up to 1m/s.

0.0002 based on utility and site condition.

Please specify MDMT according to MDT design temperature of JSW is 190C

0.00017

0.00035

21.31 °C

445.8 kW

597.8 kW

21.9 bar

6.5 bar

0.27 m/s

0.44 m/s

0.1203

0.5

0.00017

0.00035

445.8 kW

597.8 kW

21.31 °C

25 bar

-1.013 bar

20 bar

-1.013 bar

120 °C

65 °C

1 tube

2 tubes

3 tubes

3 tubes

3 tubes

1 tube

3 tubes

1 tube

3 tubes

Intermediate

130

19.05

1.2

4000

mm

mm

mm

Plain

None

SA-106 B K03006

336.6

355.6

mm

Shell cover

-

SA-106 B K03006

Tubesheet cover

-

Carbon Steel

Tubes

Impingement

-

Carbon Steel

Single segmental

26.76

mm

-

Seal Type

U-bend

0

Type

Expanded & strength welded(App.A 'e')

-

None

Bundle entrance

27

Bundle exit

26

lb/(ft-s<sup>2</sup>)

-

Tube side

Flat Metal Jacket Fibe

-

ASME Code Sec VIII Div 1

TEMA class R - refinery service

979.3

Filled with water

1326.6

Bundle

382

kg

20% OVER DESIGN HAS BEEN CONSIDERED IN OIL FLOW RATE

tube nozzle shall be located at top of channel.

shell inlet shall be located at bottom.

به نظر میرسد این مدرک با  
 آخرین pfd ارسالی چک نشد  
 است

اصلاح شد

according to  
 DPIC-12-001/000-  
 4150-ME-PFD-027  
 there is  
 discrepancy at the  
 shell  
 side.240\*60/1000=  
 12672 kg/h

please specify the  
 density for PFD to  
 controlling this  
 value

کامنت بر  
 روی مدرک  
 مورد نظر داده  
 شود

Please specify  
 MDMT according  
 to MDT design temperature  
 of JSW is 190C

اصلاح شد

6.914 bara based  
 on utility and site  
 condition.

اصلاح شد

up to 1-bar is  
 accepted.

CW velocity is too  
 low shall be  
 increased up to  
 1m/s.

تا حد ممکن اصلاح شد

0.0002 based on  
 utility and site  
 condition.

Please modify  
 according to  
 Datasheet

در طراحی  
 مکانیکی  
 بررسی میشود

اصلاح شد

shell inlet shall be located at  
 bottom.

tube nozzle shall be located at top of channel.



## Overall Summary

1	Size	336.6	X	4000	mm	Type	BEM	Hor	Connected in	1 parallel	1 series
2	Surf/Unit (gross/eff/finned)			31.1	/	30.5	/	m²	Shells/unit	1	
3	Surf/Shell (gross/eff/finned)			31.1	/	30.5	/	m²			
4	Rating / Checking	PERFORMANCE OF ONE UNIT									
5		Shell Side					Tube Side		Heat Transfer Parameters		
6	Process Data	In	Out	In	Out	Total heat load kW 257.6					
7	Total flow	kg/h	15206		22248	Eff. MTD/ 1 pass MTD °C 21.31 / 23.72					
8	Vapor	kg/h	0	0	0	0	Actual/Reqd area ratio - fouled/clean 1.13 / 1.51				
9	Liquid	kg/h	15206	15206	22248	22248					
10	Noncondensable	kg/h	0		0		Coef./Resist. W/(m²-K) m²-K/W %				
11	Cond./Evap.	kg/h	0		0		Overall fouled 445.8 0.00224				
12	Temperature	°C	80.3	50	35	45	Overall clean 597.8 0.00167				
13	Bubble Point	°C					Tube side film 2434.6 0.00041 18.31				
14	Dew Point	°C					Tube side fouling 2497.2 0.0004 17.85				
15	Vapor mass fraction		0	0	0	0	Tube wall 46758.9 2E-05 0.95				
16	Pressure (abs)	bar	21.9	21.7797	6.5	6.4709	Outside fouling 5882.4 0.00017 7.58				
17	DeltaP allow/cal	bar	0.2	0.1203	0.5	0.0291	Outside film 806 0.00124 55.31				
18	Velocity	m/s	0.28	0.27	0.44	0.44					
19	Liquid Properties						Shell Side Pressure Drop bar %				
20	Density	kg/m³	873.29	886.58	994.5	990.61	Inlet nozzle 0.00552 4.59				
21	Viscosity	cp	1.6365	2.1994	0.719	0.5964	InletspaceXflow 0.00248 2.06				
22	Specific heat	kJ/(kg-K)	2.087	1.853	4.171	4.172	Baffle Xflow 0.0832 69.16				
23	Therm. cond.	W/(m-K)	0.15	0.15	0.6232	0.6371	Baffle window 0.02277 18.93				
24	Surface tension	dynes/cm					OutletspaceXflow 0.00252 2.1				
25	Molecular weight				18.02	18.02	Outlet nozzle 0.00381 3.16				
26	Vapor Properties						Intermediate nozzles				
27	Density	kg/m³					Tube Side Pressure Drop bar %				
28	Viscosity	cp					Inlet nozzle 0.00857 29.45				
29	Specific heat	kJ/(kg-K)					Entering tubes 0.00097 3.32				
30	Therm. cond.	W/(m-K)					Inside tubes 0.01412 48.54				
31	Molecular weight						Exiting tubes 0.0013 4.48				
32	Two-Phase Properties						Outlet nozzle 0.00414 14.21				
33	Latent heat	kJ/kg					Intermediate nozzles				
34	Heat Transfer Parameters						Velocity / Rho*V2 m/s kg/(m-s²)				
35	Reynolds No. vapor						Shell nozzle inlet 1.01 898				
36	Reynolds No. liquid		2806.98	2088.58	10112.03	12190.78	Shell bundle Xflow 0.28 0.27				
37	Prandtl No. vapor						Shell baffle window 0.15 0.15				
38	Prandtl No. liquid		22.77	27.17	4.81	3.91	Shell nozzle outlet 1 885				
39	Heat Load						Shell nozzle interm				
40	Vapor only					0	m/s kg/(m-s²)				
41	2-Phase vapor					0	Tube nozzle inlet 1.3 1688				
42	Latent heat					0	Tubes 0.44 0.44				
43	2-Phase liquid					0	Tube nozzle outlet 1.31 1695				
44	Liquid only					257.6	Tube nozzle interm				
45	Tubes	files					Nozzles: (No./OD)				
46	Type		Plain	Type	Single segmental		Shell Side Tube Side				
47	ID/OD	mm	16.65 / 19.05	Number	35	Inlet	mm	1 / 88.9	1 / 88.9		
48	Length act/eff	mm	4000 / 3923.8	Cut(%d)	26.76	Outlet	mm	1 / 88.9	1 / 88.9		
49	Tube passes	2		Cut orientation	H	Intermediate	mm	/	/		
50	Tube No.	130		Spacing: c/c	mm	100	Impingement protection		None		
51	Tube pattern	30		Spacing at inlet	mm	261.9					
52	Tube pitch	mm	24	Spacing at outlet	mm	261.9					
53	Insert		None								
54	Vibration problem (HTFS / TEMA)	No /					RhoV2 violation		No		

اصلاح شد

Baffle spacing is too tight and baffle number shall be reduced.

## Overall Performance

Rating / Checking		Shell Side		Tube Side	
Total mass flow rate	kg/h	15206		22248	
Vapor mass flow rate (In/Out)	kg/h	0	0	0	0
Liquid mass flow rate	kg/h	15206	15206	22248	22248
Vapor mass fraction		0	0	0	0
Temperatures	°C	80.3	50	35	45
Bubble / Dew point	°C	/	/	/	/
Operating Pressures	bar	21.9	21.7797	6.5	6.4709
Film coefficient	W/(m²-K)	806		2434.6	
Fouling resistance	m²-K/W	0.00017		0.0004	
Velocity (highest)	m/s	0.28		0.44	
Pressure drop (allow./calc.)	bar	0.2	0.1203	0.5	0.0291
Total heat exchanged	kW	257.6			
Overall clean coeff. (plain/finned)	W/(m²-K)	597.8	/	330	4000
Overall dirty coeff. (plain/finned)	W/(m²-K)	445.8	/	Plain	
Effective area (plain/finned)	m²	30.5	/	Insert	None
Effective MTD	°C	21.31		No.	130
Actual/Required area ratio (dirty/clean)		1.13	1.51	OD	19.05
Vibration problem (HTFS)		No		Pitch	24
RhoV2 problem		No		Baffles	Single segmental
				Total cost	24255

Total M  
Errors: 1  
Input: 1  
Results  
Operati  
Notes &  
Warning

## Heat Transfer Resistance

Shell side / Fouling / Wall / Fouling / Tube side

Shell Side  Tube Side

## Resistance Distribution

Overall Coefficient / Resistance Summary			Clean	Dirty	Max Dirty
Area required (tube OD base)	m²		20.2	27.1	30.5
Area ratio: actual/required			1.51	1.13	1
Overall coefficient	W/(m²-K)		597.8	445.8	396
Overall resistance	m²-K/W		0.00167	0.00224	0.00253
Shell side fouling	m²-K/W		0	0.00017	0.00025
Tube side fouling	m²-K/W		0	0.0004	0.0006
<b>Resistance Distribution</b>	W/(m²-K)	m²-K/W	%	%	%
Shell side film	806	0.00124	74.17	55.31	49.14
Shell side fouling	5882.4	0.00017		7.58	10.06
Tube wall	46758.9	2E-05	1.28	0.95	0.85
Tube side fouling *	2497.2	0.0004		17.85	23.69
Tube side film *	2434.6	0.00041	24.55	18.31	16.27

\* Based on outside surface - Area ratio: Ao/Ai = 1.14

Shell by Shell Conditions

		Shell 1
Shell heat load	kW	257.6
Shell inlet temperature	C	80.3
Shell outlet temperature	C	50
Tube inlet temperature	C	35
Tube outlet temperature	C	45
Shell inlet vapor fraction		0
Shell outlet vapor fraction		0
Tube inlet vapor fraction		0
Tube outlet vapor fraction		0
Shell inlet pressure	bar	21.9
Shell outlet pressure	bar	21.7797
Tube inlet pressure	bar	6.5
Tube outlet pressure	bar	6.4709
Shell pressure drop	bar	0.1203
Tube pressure drop	bar	0.0291
Mean shell metal temperature	C	61.66
Mean tube metal temperature	C	48.25
Minimum tube metal temperature	C	40.06
Maximum tube metal temperature	C	54.74

File: C:\Users\goudarzi.PETROPALAYESH\...\E-PK6101-2-CONDENSER.EDR

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TEMA Sheet

اصلاح شد

Please modify the tag number.

according to  
DPIC-12-001/0  
150-ME-PFD-0  
there is  
discrepancy at  
tube side:  
 $320 \times 994.5$   
 $= 318240 \text{ kg/h}$

Refer to utility and site condition.  
Jacketed water temperature is 37-47C.

## اصلاح شد

به نظر میرسد این مدرک با  
آخرین pfd ارسالی چک نشد  
است

است

اور دیزاین  
حذف شد

Please give your technical explain about 10% oversizing

30385	
56	48

a based  
and site

According to PFD inlet temp. is 37 C.

CW velocity is low  
shall be increased  
up to 1m/s.

به دلیل آنکه در  
SHELL عمل کندانس  
انجام میگیرد احتمال  
وکیوم شدن است  
ولی TUBE احتیاجی به  
وکیوم ندارد.

9 Please clarify case  
9 Full vacuum.

اصلاح شد

اصلاح شد up to 1 bar is accepted.

Please specify right angle at the sketch of DS.

کامنت بر روی  
مدرک مربوطه  
گذاشته شود

design temperature of JSW is 190C.

0.0002 based on utility and site condition.

اصلاح شد

اور دیزاین  
حذف شد

Please give your technical explain

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Company: DEHDASHT PETROCHEMICAL INDUSTRY COMPANY

For : PK-6101

Service of Unit: CONDENSER

Item No.: E-PK1601-2

Date: Rev No.:

Size: 1180 - 6000 mm Type: BEM Horizontal

Surf/unit(eff.) 656.2 m<sup>2</sup> Shells/unit 1

parallel 1 series

ff.) 656.2 m<sup>2</sup>

PERFORMANCE OF ONE UNIT

Fluid allocation

Fluid name

Fluid

Noncondensable

Temperature (In/Out)

Bubble / Dew point

kg/m<sup>3</sup>

cp

kJ/(kg-K)

/(m-K)

kJ/kg

bar

m/s

Pressure drop, allow./calc.

Fouling resistance (min)

m<sup>2</sup>-K/W

kW

Transfer rate, Service

CONSTRUCTION OF ONE SHELL

Shell Side

Tube Side

Design/Vacuum/test pressure

Design temperature / MDMT

Number passes per shell

Corrosion allowance

Connections

Size/Rating

Nominal

Out - Vapor

Tube #: 1876

OD: 19.05

Tks. Average 2.11

mm

Length: 6000

mm

Pitch: 24

mm

Tube pattern: 60

Tube type: Plain

Insert: None

Fin#: /m

Material: SA-334 8 K81340

Shell SA-516 70 K02700

ID 1180

OD 1210

mm

Shell cover

Channel or bonnet SA-516 70 K02700

Channel cover

Tubesheet-stationary Carbon Steel

Tubesheet-floating

Floating head cover -

Impingement protection Square plate

Baffle-cross Carbon Steel

Type Single segmental

Cut(%d) 39.83

Verti Spacing: c/c 210

mm

Baffle-long -

Seal Type

Inlet 402.48

mm

Supports-tube U-bend 0

Type

Bypass seal

Tube-tubesheet joint

Expanded & strength welded(App.A'e')

Expansion joint -

Type

RhoV2-Inlet nozzle 768

Bundle entrance 753

Bundle exit 37

kg/(m-s<sup>2</sup>)

Gaskets - Shell side

Flat Metal Jacket Fibe

Tube side

Flat Metal Jacket Fibe

Floating head -

Code requirements

ASME Code Sec VIII Div 1

TEMA class R - refinery service

Weight/Shell

16540.6

Filled with water 23326.3

Bundle 11477.6

kg

Remarks

10% OVER DESIGN HAS BEEN CONSIDERED IN FLOW

به نظر میرسد این مدرک با آخرین pfd ارسالی چک نشد است

150-ME-PFD- there is discrepancy at tube side: 320\*994.5 =318240 kg/h

Site condition: Jacketed water temperature is 37-47C.

اور دیزاین حذف شد

Please give your technical explain about 10% oversizing

اصلاح شد

6.914 bara based on utility and site condition

CW velocity is low shall be increased up to 1m/s.

به دلیل آنکه در SHELL عمل کندانس انجام میگردد احتمال وکیوم شدن است ولی TUBE احتیاجی به وکیوم ندارد.

Please clarify case Full vacuum.

اصلاح شد

up to 1 bar is accepted.

Please specify right angle at the sketch of DS.

کامنت بر روی مدرک مربوطه گذاشته شود

design temperature of JSW is 190C.

0.0002 based on utility and site condition.

اور دیزاین حذف شد

Please give your technical explain

According to P Inlet temp. is 3

## Overall Summary

1	Size	1180	X	6000	mm	Type	BEM	Hor	Connected in	1 parallel	1 series				
2	Surf/Unit (gross/eff/finned)			673.6	/	656.2	/		m² Shells/unit	1					
3	Surf/Shell (gross/eff/finned)			673.6	/	656.2	/		m²						
4	Rating / Checking	PERFORMANCE OF ONE UNIT													
5			Shell Side		Tube Side		Heat Transfer Parameters								
6	Process Data		In	Out	In	Out	Total heat load kW 2941.9								
7	Total flow	kg/h		30385		254002	Eff. MTD/ 1 pass MTD °C 8.49 / 9.64								
8	Vapor	kg/h	30385	0	0	0	Actual/Reqd area ratio - fouled/clean 1.08 / 1.83								
9	Liquid	kg/h	0	30385	254002	254002									
10	Noncondensable	kg/h		0		0	Coef./Resist.	W/(m²-K)	m²-K/W						
11	Cond./Evap.	kg/h		30385		0	Overall fouled	572.1	0.00175						
12	Temperature	°C	80.3	48.33	35	45	Overall clean	966.9	0.00103						
13	Bubble Point	°C	48.56	48.47			Tube side film	3840.4	0.00026	14.9					
14	Dew Point	°C	48.56	48.47			Tube side fouling	1946.2	0.00051	29.39					
15	Vapor mass fraction		1	0	0	0	Tube wall	15249.4	7E-05	3.75					
16	Pressure (abs)	bar	19.937	19.90218	5.5	5.3094	Outside fouling	5000	0.0002	11.44					
17	DeltaP allow/cal	bar	0.1	0.03482	0.5	0.1906	Outside film	1412	0.00071	40.52					
18	Velocity	m/s	0.98	0.08	0.87	0.88									
19	Liquid Properties						Shell Side Pressure Drop		bar	%					
20	Density	kg/m³		462.02	994.45	990.56	Inlet nozzle		0.00637	18.16					
21	Viscosity	mPa-s		0.06	0.719	0.5964	InletspaceXflow		0.00295	8.41					
22	Specific heat	kJ/(kg-K)		3.321	4.171	4.172	Baffle Xflow		0.02066	58.86					
23	Therm. cond.	W/(m-K)		0.0898	0.6231	0.6371	Baffle window		0.00289	8.23					
24	Surface tension	N/m					OutletspaceXflow		0.00043	1.22					
25	Molecular weight			42.08	18.02	18.02	Outlet nozzle		0.0018	5.12					
26	Vapor Properties						Intermediate nozzles								
27	Density	kg/m³	35.84				Tube Side Pressure Drop		bar	%					
28	Viscosity	cp	0.0111				Inlet nozzle		0.00438	2.3					
29	Specific heat	kJ/(kg-K)	2.025				Entering tubes		0.00773	4.06					
30	Therm. cond.	W/(m-K)	0.0237				Inside tubes		0.16391	86.01					
31	Molecular weight		42.08				Exiting tubes		0.01205	6.32					
32	Two-Phase Properties						Outlet nozzle		0.0025	1.31					
33	Latent heat	kJ/kg	282.4	282.7			Intermediate nozzles								
34	Heat Transfer Parameters						Velocity / Rho*V2	m/s	kg/(m-s²)						
35	Reynolds No. vapor		59772.96				Shell nozzle inlet		4.63	768					
36	Reynolds No. liquid			11094.23	17849.74	21612.52	Shell bundle Xflow	0.98	0.08						
37	Prandtl No. vapor		0.95				Shell baffle window	0.4	0.03						
38	Prandtl No. liquid			2.22	4.81	3.91	Shell nozzle outlet		0.98	444					
39	Heat Load		kW			kW	Shell nozzle interm								
40	Vapor only		-551.8			0			m/s	kg/(m-s²)					
41	2-Phase vapor		-0.6			0	Tube nozzle inlet		0.97	940					
42	Latent heat		-2384.5			0	Tubes	0.87	0.88						
43	2-Phase liquid		-0.9			0	Tube nozzle outlet		0.98	944					
44	Liquid only		-4.1			2941.9	Tube nozzle interm								
45	Tubes					Baffles	Nozzles: (No./OD)								
46	Type			Plain	Type	Single segmental	Shell Side					Tube Side			
47	ID/OD	mm	14.83	/	19.05	Number	25	Inlet	mm	1	/	273.05	1	/	323.85
48	Length act/eff	cm	600	/	584.5	Cut(%d)	39.83	Outlet		1	/	168.28	1	/	323.85
49	Tube passes		4			Cut orientation	V	Intermediate		1	/	60.32		/	
50	Tube No.		1876			Spacing: c/c	mm	210	Impingement protection		Square plate				
51	Tube pattern		60			Spacing at inlet	mm	402.48							
52	Tube pitch	mm	24			Spacing at outlet	mm	402.48							
53	Insert	None													
54	Vibration problem (HTFS / TEMA)	Possible	/					RhoV2 violation	No						

## Overall Performance

Rating / Checking		Shell Side		Tube Side	
Total mass flow rate	kg/h	30385		254002	
Vapor mass flow rate (In/Out)	kg/h	30385	0	0	0
Liquid mass flow rate	kg/h	0	30385	254002	254002
Vapor mass fraction		1	0	0	0
Temperatures	°C	80.3	48.33	35	45
Bubble / Dew point	°C	48.56 / 48.56	48.47 / 48.47	/	/
Operating Pressures	bar	19.937	19.90218	5.5	5.3094
Film coefficient	W/(m²-K)	1412		3840.4	
Fouling resistance	m²-K/W	0.0002		0.00051	
Velocity (highest)	m/s	1.46		0.88	
Pressure drop (allow./calc.)	bar	0.1	0.03482	0.5	0.1906
Total heat exchanged	kW	2941.9	Unit	BEM	4 pass 1 ser 1 par
Overall clean coeff. (plain/finned)	W/(m²-K)	966.9 /	Shell size	1180	- 6000 mm Hor
Overall dirty coeff. (plain/finned)	W/(m²-K)	572.1 /	Tubes	Plain	
Effective area (plain/finned)	m²	656.2 /	Insert	None	
Effective MTD	°C	8.49	No.	1876	OD 19.05 Tks 2.11 mm
Actual/Required area ratio (dirty/clean)		1.08 / 1.83	Pattern	60	Pitch 24 mm
Vibration problem (HTFS)		Possible	Baffles	Single segmental	Cut(%d) 39.83
RhoV2 problem		No	Total cost	204540	Dollar(US)

Total M  
Errors: 1  
Input: 1  
Results  
Operati  
Notes &  
Warning

## Heat Transfer Resistance

Shell side / Fouling / Wall / Fouling / Tube side

Shell Side  Tube Side

## Resistance Distribution

Overall Coefficient / Resistance Summary			Clean	Dirty	Max Dirty
Area required (tube OD base)	m²		358.2	605.4	656.2
Area ratio: actual/required			1.83	1.08	1
Overall coefficient	W/(m²-K)		966.9	572.1	527.7
Overall resistance	m²-K/W		0.00103	0.00175	0.00189
Shell side fouling	m²-K/W		0	0.0002	0.00024
Tube side fouling	m²-K/W		0	0.00051	0.00062
<b>Resistance Distribution</b>	W/(m²-K)	m²-K/W	%	%	%
Shell side film	1412	0.00071	68.48	40.52	37.38
Shell side fouling	5000	0.0002		11.44	12.73
Tube wall	15249.4	7E-05	6.34	3.75	3.46
Tube side fouling *	1946.2	0.00051		29.39	32.7
Tube side film *	3840.4	0.00026	25.18	14.9	13.74

\* Based on outside surface - Area ratio: Ao/Ai = 1.28

Shell by Shell Conditions

		Shell 1
Shell heat load	kW	2941.9
Shell inlet temperature	C	80.3
Shell outlet temperature	C	48.33
Tube inlet temperature	C	35
Tube outlet temperature	C	45
Shell inlet vapor fraction		1
Shell outlet vapor fraction		0
Tube inlet vapor fraction		0
Tube outlet vapor fraction		0
Shell inlet pressure	bar	19.937
Shell outlet pressure	bar	19.90214
Tube inlet pressure	bar	5.5
Tube outlet pressure	bar	5.30939
Shell pressure drop	bar	0.03486
Tube pressure drop	bar	0.19061
Mean shell metal temperature	C	50.21
Mean tube metal temperature	C	44.9
Minimum tube metal temperature	C	41.33
Maximum tube metal temperature	C	52.41

## Hot Stream Composition

		<b>Total</b>	<b>Comp 1</b>	<b>Comp 2</b>
<b>Stream mass fractions</b>		1	0	1
<b>Liquid mass fractions at inlet</b>		0		
<b>Liquid mass fractions at outlet</b>		1	0	1
<b>Vapor mass fractions at inlet</b>		1	0	1
<b>Vapor mass fractions at outlet</b>		0		0
<b>Liquid 2 mass fractions at inlet</b>				
<b>Liquid 2 mass fractions at outlet</b>				
<b>Stream mole fractions</b>		1	0	1
<b>Liquid mole fractions at inlet</b>		0		
<b>Liquid mole fractions at outlet</b>		1		1
<b>Vapor mole fractions at inlet</b>		1		1
<b>Vapor mole fractions at outlet</b>		0		0
<b>Liquid-2 mole fractions at inlet</b>				
<b>Liquid-2 mole fractions at outlet</b>				
<b>Stream mass flow</b>	<b>kg/h</b>	30385	0	30385
<b>Liquid mass flow at inlet</b>	<b>kg/h</b>	0	0	0
<b>Liquid mass flow at outlet</b>	<b>kg/h</b>	30385	0	30385
<b>Vapor mass flow at inlet</b>	<b>kg/h</b>	30385	0	30385
<b>Vapor mass flow at outlet</b>	<b>kg/h</b>	0	0	0
<b>Liquid 2 mass flow at inlet</b>	<b>kg/h</b>			
<b>Liquid 2 mass flow at outlet</b>	<b>kg/h</b>			



Cold Stream Composition

		Total	Comp 1	Comp 2
Stream mass fractions		1	1	0
Liquid mass fractions at inlet		1	1	0
Liquid mass fractions at outlet		1	1	0
Vapor mass fractions at inlet		0		
Vapor mass fractions at outlet		0	0	
Liquid 2 mass fractions at inlet				
Liquid 2 mass fractions at outlet				
Stream mole fractions		1	1	0
Liquid mole fractions at inlet		1	1	
Liquid mole fractions at outlet		1	1	
Vapor mole fractions at inlet		0		
Vapor mole fractions at outlet		0	0	
Liquid-2 mole fractions at inlet				
Liquid-2 mole fractions at outlet				
Stream mass flow	kg/h	254002	254002	0
Liquid mass flow at inlet	kg/h	254002	254002	0
Liquid mass flow at outlet	kg/h	254002	254002	0
Vapor mass flow at inlet	kg/h	0	0	0
Vapor mass flow at outlet	kg/h	0	0	0
Liquid 2 mass flow at inlet	kg/h			
Liquid 2 mass flow at outlet	kg/h			

## TEMA Sheet

به نظر میرسد این مدرک با  
آخرین pfd ارسالی چک نشد  
است

## Specification Sheet

according to  
DPIC-12-001/000-4  
150-ME-PFD-027  
Type of this unit is  
kettle type. please  
shall be revise this  
unit.

according to  
DPIC-12-001/000  
4150-ME-PFD-027  
there is  
discrepancy at the  
shell side. It's  
consider that error  
to arrangement of  
shell and tube side

Design  
temperature of  
both sides shall be  
saturate  
temperature  
corresponding to  
design pressure  
which is equal to  
125C. Please  
recheck.

vacuum has  
discrepancy with  
economizer data  
sheet page #3

Please clarify why  
design pressure of  
economizer and  
water cooler is  
higher than chiller.

کامنت بر روی  
دیتاشیت مکانیکی داده  
شود

Please check the  
UC566 and PWHT  
attention to MDMT

According to MDS,  
material of baffle-  
cross shall be  
modified.

در طراحی مکانیکی بررسی  
میشود

در طراحی مکانیکی بررسی  
میشود

1	Company:		
2	Location:		
3	Service of Unit: ECONOMIZER	Our Reference:	
4	Item No.: E-PK6101-3	Your Reference:	
5	Date:	Rev No.: 00	Job No.:
6	Size: 591 - 6000 mm	Type: BEM	Horizontal
7	Surf/unit(eff.)	117.3 m <sup>2</sup>	Shells/unit 1
8	PERFORMANCE OF ONE		
9	Fluid allocation	Shell	Tube Side
10	Fluid name	PROPYLENE	PROPYLENE
11	Fluid quantity, Total	21450 kg/h	8174 kg/h
12		0 kg/h	2370 kg/h
13		21450 kg/h	5804 kg/h
14		0 kg/h	0 kg/h
15		48.55 °C	12.37 °C
16		48.56 / 48.56 °C	12.37 / 12.37 °C
17		48.36 / 48.36 °C	12.37 / 12.37 °C
18		17.36 / 526.76 kg/m <sup>3</sup>	17.02 / 526.76 kg/m <sup>3</sup>
19		0.0087 / 0.0933 mPa-s	0.0087 / 0.0933 mPa-s
20		42.08 kJ/(kg-K)	42.08 kJ/(kg-K)
21		1.65 / 2.578 W/(m-K)	1.655 / 2.578 W/(m-K)
22		0.0162 / 0.1081 kJ/kg	0.0165 / 0.1081 kJ/kg
23		19.94 bar	19.85263 bar
24	Latent heat	360 kJ/kg	360 kJ/kg
25	Pressure (abs)	8.3 bar	8.25237 bar
26	Velocity (Mean/Max)	0.33 / 0.39 m/s	2.36 / 5.14 m/s
27	Pressure drop, allow./calc.	0.25 bar	0.04763 bar
28	Fouling resistance (min)	0.00017 m <sup>2</sup> -K/W	0.00017 m <sup>2</sup> -K/W
29	Heat transfer	512.7 kW	638.3 kW
30	MTD (corrected)	1.81 °C	1.81 °C
31	Dirty	512.7 kW	638.3 kW
32	Clean	512.7 kW	638.3 kW
33	W/(m <sup>2</sup> -K)	512.7 W/(m <sup>2</sup> -K)	638.3 W/(m <sup>2</sup> -K)
34	CONSTRUCTION OF ONE SHELL		
35	Shell Side	Tube Side	
36	bar	23 / 0 / 29.9	23 / 0 / 29.9
37	°C	120 / -45	120 / -45
38	mm	3	3
39	in	1 / 6	1 / 6
40	ANSI	300	300
41	Intermediate	6000 mm	6000 mm
42	Insert:None	In#: #/m	In#: #/m
43	Shell SA-516 70 K02700	OD 609.6 mm	Shell cover
44	Channel or bonnet SA-516 70 K02700	Channel cover	
45	Tubesheet-stationary	SA-516 70 K02700	Sheet-floating
46	Floating head cover	-	ement protection
47	Baffle-cross SA-285 C K02801	Type Single seg	HorizSpacing
48	Baffle-long	Seal Type	Inlet 307 mm
49	Supports-tube	U-bend	Type
50	Bypass seal	Tube-tubesheet joint	Expanded only (2 grooves)(App.A 'i')
51	Expansion joint	Type None	
52	RhoV2-Inlet nozzle 272	Bundle entrance 119	Bundle exit 105 kg/(m-s <sup>2</sup> )
53	Gaskets - Shell side	Flat Metal Jacket Fibe	Jacket Fibe
54	Floating head	-	
55	Code requirements	ASME Code Sec VIII Div 1	
56	Weight/Shell	4009.6 Filled with water 5509.4	Bundle 2659.5 kg
57	Remarks		
58			

Overall Summary

1	Size	590.6	X	6000	mm	Type	BEM	Hor	Connected in	1 parallel	1 series
2	Surf/Unit (gross/eff/finned)	119.2	/	117.3	/	m <sup>2</sup>	Shells/unit	1			
3	Surf/Shell (gross/eff/finned)	119.2	/	117.3	/	m <sup>2</sup>					
4	Rating / Checking	PERFORMANCE OF ONE UNIT									
5	Shell Side					Tube Side		Heat Transfer Parameters			
6	Process Data	In	Out	In	Out	Total heat load	kW	590.2			
7	Total flow	kg/h	21450	8174		Eff. MTD/ 1 pass MTD	°C	11.81	/	11.75	
8	Vapor	kg/h	0	0	2370	Actual/Reqd area ratio - fouled/clean	1.2	/	1.5		
9	Liquid	kg/h	21450	21450	5804	0					
10	Noncondensable	kg/h	0	0	0	Coef./Resist.	W/(m <sup>2</sup> -K)	m <sup>2</sup> -K/W	%		
11	Cond./Evap.	kg/h	0	5804		Overall fouled	512.7	0.00195			
12	Temperature	°C	48.55	14	12.37	Overall clean	638.3	0.00157			
13	Bubble Point	°C	48.56	48.36	12.37	Tube side film	1393.5	0.00072	36.8		
14	Dew Point	°C	48.56	48.36	12.37	Tube side fouling	4678.1	0.00021	10.96		
15	Vapor mass fraction	0	0	0.29	1	Tube wall	20882	5E-05	2.46		
16	Pressure (abs)	bar	19.94	19.85263	8.3	Outside fouling	5882.4	0.00017	8.72		
17	DeltaP allow/cal	bar	0.25	0.08738	0.2	Outside film	1248.3	0.0008	41.07		
18	Velocity	m/s	0.31	0.28	1.58	5.14					
19	Liquid Properties					Shell Side Pressure Drop	bar	%			
20	Density	kg/m <sup>3</sup>	461.41	524.12	526.76	Inlet nozzle	0.002	2.29			
21	Viscosity	cp	0.0598	0.0915	0.0933	InletspaceXflow	0.00187	2.14			
22	Specific heat	kJ/(kg-K)	3.332	2.558	2.578	Baffle Xflow	0.05507	63.01			
23	Therm. cond.	W/(m-K)	0.0897	0.1072	0.1081	Baffle window	0.02558	29.27			
24	Surface tension	N/m			0.0072	OutletspaceXflow	0.00169	1.93			
25	Molecular weight		42.08	42.08	42.08	Outlet nozzle	0.00123	1.41			
26	Vapor Properties					Intermediate nozzles					
27	Density	kg/m <sup>3</sup>			17.36	17.02	Tube Side Pressure Drop	bar	%		
28	Viscosity	mPa-s			0.0087	0.0087	Inlet nozzle	0.01092	24.75		
29	Specific heat	kJ/(kg-K)			1.65	1.655	Entering tubes	0.00142	3.23		
30	Therm. cond.	W/(m-K)			0.0162	0.0165	Inside tubes	0.02562	58.04		
31	Molecular weight				42.08	42.08	Outlet nozzle	0.00348	7.88		
32	Two-Phase Properties						Intermediate nozzles				
33	Latent heat	kJ/kg			360	360					
34	Heat Transfer Parameters					Velocity / Rho*V2	m/s	kg/(m-s <sup>2</sup> )			
35	Reynolds No. vapor				59183.27	202410.7	Shell nozzle inlet	0.77	272		
36	Reynolds No. liquid	61405.68	40123.33	13442.3			Shell bundle Xflow	0.31	0.28		
37	Prandtl No. vapor				0.88	0.88	Shell baffle window	0.21	0.18		
38	Prandtl No. liquid	2.22	2.18	2.23			Shell nozzle outlet	0.68	240		
39	Heat Load	kW			kW		Shell nozzle interm				
40	Vapor only				0	580.4					
41	2-Phase vapor				0	0	Tube nozzle inlet	6.16	2101		
42	Latent heat				0	0	Tubes	1.58	5.14		
43	2-Phase liquid				0	0	Tube nozzle outlet	7.93	1071		
44	Liquid only	-590.2			0	0	Tube nozzle interm				
45	Tubes				Baffles		Nozzles: (No./OD)				
46	Type	Plain	Type	Single segmental			Shell Side	Tube Side			
47	ID/OD	mm 20.2 / 25.4	Number	47			Inlet	mm 1 / 168.28	1 / 114.3		
48	Length act/eff	cm 600 / 590.4	Cut(%d)	15.4			Outlet	1 / 168.28	1 / 168.28		
49	Tube passes	3	Cut orientation	H			Intermediate	/	/		
50	Tube No.	249	Spacing: c/c	mm 115			Impingement protection	None			
51	Tube pattern	30	Spacing at inlet	mm 307							
52	Tube pitch	mm 32	Spacing at outlet	mm 307							
53	Insert	None									
54	Vibration problem (HTFS / TEMA)	No /					RhoV2 violation		No		

## Overall Performance

Rating / Checking		Shell Side		Tube Side	
Total mass flow rate	kg/h	21450		8174	
Vapor mass flow rate (In/Out)	kg/h	0	0	2370	8174
Liquid mass flow rate	kg/h	21450	21450	5804	0
Vapor mass fraction		0	0	0.29	1
Temperatures	°C	48.55	14	12.37	15
Bubble / Dew point	°C	48.56 / 48.56	48.36 / 48.36	12.37 / 12.37	12.37 / 12.37
Operating Pressures	bar	19.94	19.85263	8.3	8.25237
Film coefficient	W/(m²-K)	1248.3		1393.5	
Fouling resistance	m²-K/W	0.00017		0.00021	
Velocity (highest)	m/s	0.39		5.14	
Pressure drop (allow./calc.)	bar	0.25	0.08738	0.2	0.04763
Total heat exchanged	kW	590.2	Unit	BEM	3 pass 1 ser 1 par
Overall clean coeff. (plain/finned)	W/(m²-K)	638.3 /	Shell size	591 - 6000	mm Hor
Overall dirty coeff. (plain/finned)	W/(m²-K)	512.7 /	Tubes	Plain	
Effective area (plain/finned)	m²	117.3 /	Insert	None	
Effective MTD	°C	11.81	No.	249 OD 25.4	Tks 2.6 mm
Actual/Required area ratio (dirty/clean)		1.2 / 1.5	Pattern	30 Pitch 32	mm
Vibration problem (HTFS)		No	Baffles	Single segmental	Cut(%d) 15.4
RhoV2 problem		No	Total cost	46284	Dollar(US)

Total M  
Errors:  
Input: 0  
Results  
Operati  
Notes 8  
Warning

## Heat Transfer Resistance

Shell side / Fouling / Wall / Fouling / Tube side

Shell Side  Tube Side

## Resistance Distribution

Overall Coefficient / Resistance Summary			Clean	Dirty	Max Dirty
Area required (tube OD base)	m²		78.3	97.5	117.3
Area ratio: actual/required			1.5	1.2	1
Overall coefficient	W/(m²-K)		638.3	512.7	425.9
Overall resistance	m²-K/W		0.00157	0.00195	0.00235
Shell side fouling	m²-K/W		0	0.00017	0.00035
Tube side fouling	m²-K/W		0	0.00021	0.00044
<b>Resistance Distribution</b>	W/(m²-K)	m²-K/W	%	%	%
Shell side film	1248.3	0.0008	51.13	41.07	34.12
Shell side fouling	5882.4	0.00017		8.72	14.74
Tube wall	20882	5E-05	3.06	2.46	2.04
Tube side fouling *	4678.1	0.00021		10.96	18.53
Tube side film *	1393.5	0.00072	45.81	36.8	30.57

\* Based on outside surface - Area ratio: Ao/Ai = 1.26

Shell by Shell Conditions

		Shell 1
Shell heat load	kW	590.2
Shell inlet temperature	C	48.55
Shell outlet temperature	C	14
Tube inlet temperature	C	12.37
Tube outlet temperature	C	15
Shell inlet vapor fraction		0
Shell outlet vapor fraction		0
Tube inlet vapor fraction		0.29
Tube outlet vapor fraction		1
Shell inlet pressure	bar	19.94
Shell outlet pressure	bar	19.85262
Tube inlet pressure	bar	8.3
Tube outlet pressure	bar	8.25236
Shell pressure drop	bar	0.08738
Tube pressure drop	bar	0.04764
Mean shell metal temperature	C	24.32
Mean tube metal temperature	C	18.44
Minimum tube metal temperature	C	13.05
Maximum tube metal temperature	C	43.21