HEAT EXCHANGER RATING DATA SHEET

SI Units

					Job No.			
Customer	MAN Turbo & Diesel SE				Reference No.			
Address					Proposal No.	914066		
Plant Location	JOHNCO				Date	15.10.2014	Rev 4	
Service of Unit	Cooler 2.2 - 2-S				Item No.			
Size	1200 x 7500	Type BEP	Horz.		Connected In	1	Parallel 1	Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1		Surf/Shell (Gross/Eff)	534,85 / 514,88 m2		

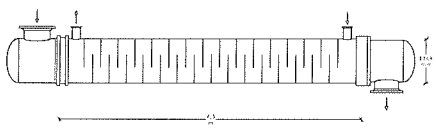
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	41,0002		61,1073	
Vapor (In/Out)				61,1073	61,0804
Liquid		41,0002	41,0002		0,0269
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	36,52	50,00	31,60
Density	kg/m3	1058,7	1052,5	67,896	75,325 V/L 1001,3
Viscosity	cP	3,0325	2,2916	0,0177	0,0172 V/L 0,7398
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3913	1,1205	1,1781 V/L 4,1841
Thermal Conductivity	W/m-C	0,4128	0,4100	0,0220	0,0207 V/L 0,5954
Latent Heat	kJ/kg			2272,93	2460,85
Inlet Pressure	bar	6,000		35,431	
Velocity x/w	m/s	0,43 / 0,53		2,93	
Pressure Drop, Allow/Calc	bar	1,000	0,441	0,040	0,033
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged	1357, kW	MTD (Corrected) 8,1 C	Overdesign 4,49 %	
Transfer Rate, Service	325,16 W/m2-K	Calculated 339,76 W/m2-K	Clean 350,48 W/m2-K	

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No. 1135	OD 20,000 mm	Thk(Avg) 1,000 mm	Length 7,500 m	Pitch	Layout 30
Tube Type	Plain		Material SS 316L		
Shell Carbon steel	ID	OD mm	Shell Cover		
Channel or Bonnet	SS 316L		Channel Cover		
Tubesheet-Stationary	SS 316L		Tubesheet-Floating	SS 316L	
Floating Head Cover			Impingement Plate	None	
Baffles-Cross	SS 316L Type	%Cut (Diam)	Spacing(c/c)	Inlet	
Baffles-Long		Seal Type			
Supports-Tube		U-Bend	Type		
Bypass Seal Arrangement		Tube-Tubesheet Joint			
Expansion Joint		Type			
Rho-V2-Inlet Nozzle	1524,22 kg/m-s2	Bundle Entrance 78,29	Bundle Exit 78,75	kg/m-s2	
Gaskets-Shell Side		Tube Side			
-Floating Head					
Code Requirements	ASME VIII, Div. 1; U-Stamp		TEMA Class C		
Weight/Shell 18506,7	Filled with Water 28567,1		Bundle 6997,32	kg	

Remarks:

MDMT -17,78 °C

HEAT EXCHANGER RATING DATA SHEET

SI Units

					Job No.			
Customer	MAN Turbo & Diesel SE				Reference No.			
Address					Proposal No.	914066		
Plant Location	JOHNCO				Date	15.10.2014	Rev 4	
Service of Unit	Cooler 2.2 - 2-I				Item No.			
Size	1200 x 7500	Type BEP	Horz.		Connected In	1	Parallel 1	Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1		Surf/Shell (Gross/Eff)	534,85 / 514,88 m2		

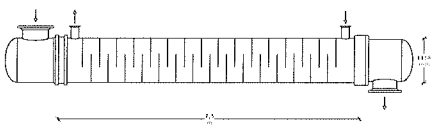
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	41,0002		61,1193	
Vapor (In/Out)				61,1193	61,0958
Liquid		41,0002	41,0002		0,0235
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	36,49	50,00	31,60
Density	kg/m3	1058,7	1052,6	67,873	75,591 V/L 1001,3
Viscosity	cP	3,0325	2,2939	0,0177	0,0172 V/L 0,7465
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3911	1,1204	1,1731 V/L 4,1805
Thermal Conductivity	W/m-C	0,4128	0,4101	0,0220	0,0208 V/L 0,5947
Latent Heat	kJ/kg			2406,15	2407,50
Inlet Pressure	bar	6,000		35,421	
Velocity x/w	m/s	0,43 / 0,53		2,92	
Pressure Drop, Allow/Calc	bar	1,000	0,441	0,040	0,033
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged	1352, kW	MTD (Corrected) 8,1 C	Overdesign 4,86 %
Transfer Rate, Service	322,86 W/m2-K	Calculated 338,57 W/m2-K	Clean 349,21 W/m2-K

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No.	1135	OD 20,000 mm	Thk(Avg) 1,000 mm	Length 7,500 m	Pitch	Layout 30	
Tube Type	Plain			Material SS 316L			
Shell Carbon steel		ID	OD mm	Shell Cover			
Channel or Bonnet		SS 316L		Channel Cover			
Tubesheet-Stationary		SS 316L		Tubesheet-Floating	SS 316L		
Floating Head Cover				Impingement Plate	None		
Baffles-Cross	SS 316L	Type	%Cut (Diam)	Spacing(c/c)	Inlet		
Baffles-Long			Seal Type				
Supports-Tube			U-Bend	Type			
Bypass Seal Arrangement			Tube-Tubesheet Joint				
Expansion Joint			Type				
Rho-V2-Inlet Nozzle		1524,22 kg/m-s2	Bundle Entrance 78,29	Bundle Exit	78,74	kg/m-s2	
Gaskets-Shell Side			Tube Side				
-Floating Head							
Code Requirements		ASME VIII, Div. 1; U-Stamp		TEMA Class C			
Weight/Shell	18506,7	Filled with Water 28567,1		Bundle 6997,32	kg		

Remarks:

MDMT -17,78 °C

HEAT EXCHANGER RATING DATA SHEET

SI Units

				Job No.				
Customer	MAN Turbo & Diesel SE			Reference No.				
Address				Proposal No.	914066			
Plant Location	JOHNCO			Date	15.10.2014		Rev 4	
Service of Unit	Cooler 2.2 - 2-W			Item No.				
Size	1200 x 7500	Type BEP	Horz.	Connected In	1	Parallel 1		Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1	Surf/Shell (Gross/Eff)	534,85 / 514,88 m2			

PERFORMANCE OF ONE UNIT

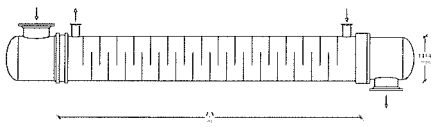
Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	41,0002		61,1243	
Vapor (In/Out)				61,1243	61,1008
Liquid		41,0002	41,0002		0,0236
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	36,51	50,00	31,60
Density	kg/m3	1058,7	1052,5	67,896	75,708 V/L 1001,3
Viscosity	cP	3,0325	2,2927	0,0177	0,0172 V/L 0,7465
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3912	1,1205	1,1738 V/L 4,1804
Thermal Conductivity	W/m-C	0,4128	0,4100	0,0220	0,0208 V/L 0,5947
Latent Heat	kJ/kg			2405,99	2405,99
Inlet Pressure	bar	6,000		36,001	
Velocity x/w	m/s	0,43 / 0,53		2,92	
Pressure Drop, Allow/Calc	bar	1,000	0,441	0,040	0,033
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged 1355, kW MTD (Corrected) 8,1 C Overdesign 4,53 %

Transfer Rate, Service 323,96 W/m2-K Calculated 338,64 W/m2-K Clean 349,29 W/m2-K

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No. 1135 OD 20,000 mm Thk(Avg) 1,000 mm Length 7,500 m Pitch Layout 30

Tube Type Plain Material SS 316L

Shell Carbon steel ID OD mm Shell Cover

Channel or Bonnet SS 316L Channel Cover

Tubesheet-Stationary SS 316L Tubesheet-Floating SS 316L

Floating Head Cover Impingement Plate None

Baffles-Cross SS 316L Type %Cut (Diam) Spacing(c/c) Inlet

Baffles-Long Seal Type

Supports-Tube U-Bend Type

Bypass Seal Arrangement Tube-Tubesheet Joint

Expansion Joint Type

Rho-V2-Inlet Nozzle 1524,22 kg/m-s2 Bundle Entrance 78,29 Bundle Exit 78,74 kg/m-s2

Gaskets-Shell Side Tube Side

-Floating Head

Code Requirements ASME VIII, Div. 1; U-Stamp TEMA Class C

Weight/Shell 18506,7 Filled with Water 28567,1 Bundle 6997,32 kg

Remarks:

MDMT -17,78 °C

HEAT EXCHANGER RATING DATA SHEET

SI Units

					Job No.			
Customer	MAN Turbo & Diesel SE				Reference No.			
Address					Proposal No.	914066		
Plant Location	JOHNCO				Date	15.10.2014	Rev 4	
Service of Unit	Cooler 2.2 - Min. Pressure				Item No.			
Size	1200 x 7500	Type BEP	Horz.		Connected In	1	Parallel 1	Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1		Surf/Shell (Gross/Eff)	534,85 / 514,88 m2		

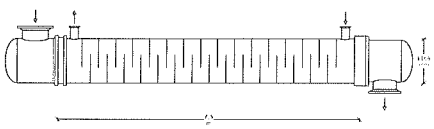
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	41,0002		45,3202	
Vapor (In/Out)				45,3202	45,2904
Liquid		41,0002	41,0002		0,0298
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	34,32	50,00	29,90
Density	kg/m3	1058,7	1053,9	52,886	58,664 V/L 1001
Viscosity	cP	3,0325	2,4330	0,0173	0,0167 V/L 0,7776
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3817	1,0587	1,0843 V/L 4,1873
Thermal Conductivity	W/m-C	0,4128	0,4107	0,0213	0,0198 V/L 0,5951
Latent Heat	kJ/kg			2410,97	2411,36
Inlet Pressure	bar	6,000		28,670	
Velocity x/w	m/s	0,43 / 0,53		2,77	
Pressure Drop, Allow/Calc	bar	1,000	0,445	0,040	0,026
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged	1051, kW	MTD (Corrected) 7,6 C	Overdesign 3,66 %	
Transfer Rate, Service	268,96 W/m2-K	Calculated 278,81 W/m2-K	Clean 285,99 W/m2-K	

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No. 1135	OD 20,000 mm	Thk(Avg) 1,000 mm	Length 7,500 m	Pitch	Layout 30	
Tube Type	Plain		Material SS 316L			
Shell Carbon steel	ID	OD mm	Shell Cover			
Channel or Bonnet	SS 316L		Channel Cover			
Tubesheet-Stationary	SS 316L		Tubesheet-Floating	SS 316L		
Floating Head Cover			Impingement Plate	None		
Baffles-Cross	SS 316L Type	%Cut (Diam)	Spacing(c/c)	Inlet		
Baffles-Long		Seal Type				
Supports-Tube		U-Bend	Type			
Bypass Seal Arrangement		Tube-Tubesheet Joint				
Expansion Joint		Type				
Rho-V2-Inlet Nozzle	1524,22 kg/m-s2	Bundle Entrance 78,29	Bundle Exit 78,64	kg/m-s2		
Gaskets-Shell Side		Tube Side				
-Floating Head						
Code Requirements	ASME VIII, Div. 1; U-Stamp		TEMA Class C			
Weight/Shell 18506,7	Filled with Water 28567,1		Bundle 6997,32	kg		

Remarks:

MDMT -17,78 °C

HEAT EXCHANGER RATING DATA SHEET

SI Units

				Job No.			
Customer	MAN Turbo & Diesel SE			Reference No.			
Address				Proposal No.	914066		
Plant Location	JOHNCO			Date	15.10.2014	Rev	3
Service of Unit	Cooler 2.2 - Max. Pressure			Item No.			
Size	1200 x 7500	Type	BEP	Horz.	Connected In	1 Parallel 1	Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1		Surf/Shell (Gross/Eff)	534,85 / 514,88 m2	

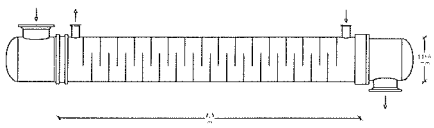
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	41,0002		61,1143	
Vapor (In/Out)				61,1143	61,0832
Liquid		41,0002	41,0002		0,0311
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	37,00	50,00	31,70
Density	kg/m3	1058,7	1052,2	77,989	87,324 V/L 1002
Viscosity	cP	3,0325	2,2628	0,0179	0,0175 V/L 0,7355
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3933	1,1654	1,2488 V/L 4,1815
Thermal Conductivity	W/m-C	0,4128	0,4099	0,0225	0,0213 V/L 0,5935
Latent Heat	kJ/kg			2348,42	2458,23
Inlet Pressure	bar	6,000		39,691	
Velocity x/w	m/s	0,43 / 0,53		2,54	
Pressure Drop, Allow/Calc	bar	1,000	0,440	0,040	0,030
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged	1423, kW	MTD (Corrected)	8,0 C	Overdesign 0,97 %
Transfer Rate, Service	344,49 W/m2-K	Calculated	347,84 W/m2-K	Clean 359,08 W/m2-K

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No.	1135	OD	20,000 mm	Thk(Avg) 1,000 mm	Length 7,500 m	Pitch Layout 30
Tube Type	Plain				Material SS 316L	
Shell	Carbon steel	ID		OD mm	Shell Cover	
Channel or Bonnet		SS 316L			Channel Cover	
Tubesheet-Stationary		SS 316L			Tubesheet-Floating	SS 316L
Floating Head Cover					Impingement Plate	None
Baffles-Cross	SS 316L	Type		%Cut (Diam)	Spacing(c/c)	Inlet
Baffles-Long				Seal Type		
Supports-Tube				U-Bend	Type	
Bypass Seal Arrangement				Tube-Tubesheet Joint		
Expansion Joint				Type		
Rho-V2-Inlet Nozzle		1524,22 kg/m-s2		Bundle Entrance 78,29	Bundle Exit 78,77	kg/m-s2
Gaskets-Shell Side				Tube Side		
-Floating Head						
Code Requirements		ASME VIII, Div. 1; U-Stamp			TEMA Class C	
Weight/Shell	18506,7		Filled with Water	28567,1	Bundle 6997,32	kg

Remarks:

MDMT -17,78 °C

HEAT EXCHANGER RATING DATA SHEET

SI Units

				Job No.			
Customer	MAN Turbo & Diesel SE			Reference No.			
Address				Proposal No.	914066		
Plant Location	JOHNCO			Date	15.10.2014	Rev	4
Service of Unit	Cooler 2.2 - Umblasefall			Item No.			
Size	1200 x 7500	Type	BEP	Horz.	Connected In	1 Parallel 1	Series
Surf/Unit (Gross/Eff)	534,85 / 514,88 m2	Shell/Unit	1		Surf/Shell (Gross/Eff)	534,85 / 514,88 m2	

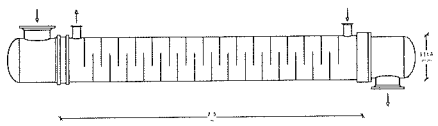
PERFORMANCE OF ONE UNIT

Fluid Allocation		Shell Side		Tube Side	
Fluid Name		Water/Glycol 50/50		Wet CO2	
Fluid Quantity, Total	kg/s	49,6073		78,0004	
Vapor (In/Out)				78,0004	77,9676
Liquid		49,6073	49,6073		0,0328
Steam					
Water					
Noncondensables					
Temperature (In/Out)	C	26,70	36,70	50,00	32,20
Density	kg/m3	1058,7	1052,4	67,873	74,990 V/L 1001
Viscosity	cP	3,0325	2,2807	0,0177	0,0172 V/L 0,7311
Molecular Weight, Vapor					
Molecular Weight, Noncondensables					
Specific Heat	kJ/kg-C	3,3483	3,3921	1,1204	1,1825 V/L 4,1866
Thermal Conductivity	W/m-C	0,4128	0,4100	0,0220	0,0208 V/L 0,5965
Latent Heat	kJ/kg			2256,39	2373,51
Inlet Pressure	bar	6,000		35,431	
Velocity x/w	m/s	0,52 / 0,64		3,76	
Pressure Drop, Allow/Calc	bar	1,000	0,612	0,040	0,052
Fouling Resistance (min)	m2-K/W	0,000090			

Heat Exchanged	1672, kW	MTD (Corrected) 8,5 C	Overdesign 4,44 %	
Transfer Rate, Service	383,62 W/m2-K	Calculated 400,67 W/m2-K	Clean 415,66 W/m2-K	

CONSTRUCTION OF ONE SHELL

Sketch (Bundle/Nozzle Orientation)



			Shell Side	Tube Side
Design/Test Pressure		barG	10,000 /	45,000 /
Design Temperature		C	100,00	120,00
No Passes per Shell			1	1
Corrosion Allowance		mm	3,00	0
Flow Direction				
Connections	In	mm	1 @ 8"	1 @ 26"
Size &	Out	mm	1 @ 8"	1 @ 24"
Rating	Liq. Out	mm	@	@

Tube No. 1135	OD 20,000 mm	Thk(Avg) 1,000 mm	Length 7,500 m	Pitch	Layout 30	
Tube Type	Plain		Material SS 316L			
Shell Carbon steel	ID	OD mm	Shell Cover			
Channel or Bonnet	SS 316L		Channel Cover			
Tubesheet-Stationary	SS 316L		Tubesheet-Floating	SS 316L		
Floating Head Cover			Impingement Plate	None		
Baffles-Cross	SS 316L Type	%Cut (Diam)	Spacing(c/c)	Inlet		
Baffles-Long		Seal Type				
Supports-Tube		U-Bend	Type			
Bypass Seal Arrangement		Tube-Tubesheet Joint				
Expansion Joint		Type				
Rho-V2-Inlet Nozzle	2231,35 kg/m-s2	Bundle Entrance 114,60	Bundle Exit 115,29	kg/m-s2		
Gaskets-Shell Side		Tube Side				
-Floating Head						
Code Requirements	ASME VIII, Div. 1; U-Stamp		TEMA Class C			
Weight/Shell 18506,7	Filled with Water 28567,1		Bundle 6997,32	kg		

Remarks:

MDMT -17,78 °C