ARVOS GmbH
SCHMIDTSCHE SCHACK
Ellenbacher Straße 10
34123 Kassel, Germany

TECHNICAL SPECIFICATIONS

CLIENT	**Braskem S. A.**
PROJECT	**Projeto Helius**
RFQ NO.	**PJ-0602056**
ARVOS OFFER NO.	**23.10.014**
ARVOS DOC. NO.	**23.10.014TS000**
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0	Apr. 27, 23	For approval	Horn Thomas 2023.04.27 11:55:32 +02'00'	Thorsten Schlieter 2023.04.27 12:02:16 +02'00'
Rev.	Date	Description	Execution by	Approved by

ARVOS GmbH SCHMIDTSCHE SCHACK Ellenbacher Straße 10, 34123 Kassel Germany	**Round-Type Transfer Line Exchanger**	ARVOS No.: 23.10.014
	Client: Braskem S. A.	Client No.: PJ-0602056
	Project: Projeto Helius	Spec. No.: N - 1

1	Number of Units 3			Arrangement: vertical upflow		
2	Item No. EA-4107 A/B/C					
3	Operating Case Design Case					
4	**Performance of one Unit**					
5			Shell Side	Tube Side		
6	Fluid		Water / Steam	Furnace Effluent		
7	Total Fluid Entering	kg/h	1)	14.500	Mol. Wt. 23,844	
8	Hydrocarbon	kg/h			Mol. Wt.	
9	Hydrogen	kg/h			Mol. Wt. 2,016	
10	Steam	kg/h	17.038 1) 3)		Mol. Wt. 18,016	
11	Operating Pressure	bar a	122,9	In: 2,23	Out:	1)
12	Operating Temperature	°C	326,2	In: 844,6	Out: 375,3	1)
13						
14	Density	kg/m^3				2)
15	Viscosity	cP				2)
16	Spec. Heat	kJ/kg°C				2)
17	Thermal Conductivity	W/m°C				2)
18						
19	Number of Passes		1	1		
20	Mass Velocity	kg/m^2s				
21	Average Velocity	m/s				
22	Pressure Loss (Diff. in Static Press.)	bar		0,068		1)
23	Fouling Resistance	$m^2°C/W$	0,000086	0		
24	Heat Exchanged	kW	5.623,4			1)
25	Heat Transfer Coefficient	$W/m^2°C$				
26	Transfer Rate Service	$W/m^2°C$	Refer to O. D. of Inner Tube			
27	Log. Mean Temp. Diff.	°C				
28	Required Surface	m^2	Refer to O. D. of Inner Tube			
29	Required Tube Length	mm				
30	Installed Tube Length	mm	8.600			
31	Installed Surface	m^2	104,72	Refer to O. D. of Inner Tube		
32	Steam Generated at Sat. Temp.	kg/h	17.038 1) 3)			
33						
34	**Construction of one Unit** 4)					
35	Design Code		AD 2000	AD 2000		
36	Design Pressure	kg/cm^2g	140,5	3,5		
37	Test Pressure	kg/cm^2g	according to code	according to code		
38	Tube No.		76			

		Size	Corr. Allow.	Material	Design Metal Temp.
39					
40	Oval Headers from Tube	o. d. 108 x 11 thk.	0	16Mo3	370 °C
41	Outer Tube	o. d. 73 x 5,6 thk.	0	16Mo3	350 °C
42	Inner Tube	o. d. 51 x 5 thk.	0	16Mo3	370 °C
43	Downcomer Header	o. d. 8"	3	SA 106M Gr. B	350 °C
44	Riser Header	o. d. 8"	3	SA 106M Gr. B	350 °C
45	Inlet Flange 5)	18", 300 lb, RF	3	16Mo3	450 °C
46	Outlet Flange	14", 300 lb	3	13CrMo4-5	550 °C
47	Inlet Channel/Main Flange	cone 5) / DN 1250	3	16Mo3 / 16Mo3	450/450 °C
48	Outlet Channel/Main Flange	cylindrical / DN 1150	3	13CrMo4-5 / 13CrMo4-5	550 °C
49	Weight empty, approx.: 14.300 kg			Weight with water, approx.:	kg
50	For main dimensions refer to drawing no. 23.10.014-HP-04.0-001-R0				
51	***Remarks***: 1) for clean conditions / 2) refer to mean pressure and mean temperature / 3) under consideration of 1 % heat loss 4) all values without dimensions are in mm / 5) existing cone will be reused				

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ARVOS GmbH SCHMIDTSCHE SCHACK Ellenbacher Straße 10, 34123 Kassel Germany	**Round-Type Transfer Line Exchanger**	ARVOS No.: 23.10.014
	Client: Braskem S. A.	Client No.: PJ-0602056
	Project: Projeto Helius	Spec. No.: N - 2

1	Number of Units	3		Arrangement: vertical upflow		
2	Item No.	EA-4107 A/B/C				
3	Operating Case	Rating Case 1				
4	**Performance of one Unit**					
5			Shell Side	Tube Side		
6	Fluid		Water / Steam	Furnace Effluent		
7	Total Fluid Entering	kg/h	1)	16.500	Mol. Wt.	24,434
8	Hydrocarbon	kg/h			Mol. Wt.	
9	Hydrogen	kg/h			Mol. Wt.	2,016
10	Steam	kg/h	18.347 1) 3)		Mol. Wt.	18,016
11	Operating Pressure	bar a	123,9	In: 2,24	Out:	1)
12	Operating Temperature	°C	326,6	In: 823,4	Out: 378,4	1)
13						
14	Density	kg/m^3				2)
15	Viscosity	cP				2)
16	Spec. Heat	kJ/kg°C				2)
17	Thermal Conductivity	W/m°C				2)
18						
19	Number of Passes		1	1		
20	Mass Velocity	kg/m^2s				
21	Average Velocity	m/s				
22	Pressure Loss (Diff. in Static Press.)	bar		0,084		1)
23	Fouling Resistance	$m^2°C/W$	0,000086	0		
24	Heat Exchanged	kW	6.036,4			1)
25	Heat Transfer Coefficient	$W/m^2°C$				
26	Transfer Rate Service	$W/m^2°C$	Refer to O. D. of Inner Tube			
27	Log. Mean Temp. Diff.	°C				
28	Required Surface	m^2	Refer to O. D. of Inner Tube			
29	Required Tube Length	mm				
30	Installed Tube Length	mm	8.600			
31	Installed Surface	m^2	104,72	Refer to O. D. of Inner Tube		
32	Steam Generated at Sat. Temp.	kg/h	18.347 1) 3)			
33						
34	**Construction of one Unit** 4)					
35	Design Code		AD 2000	AD 2000		
36	Design Pressure	kg/cm^2g	140,5	3,5		
37	Test Pressure	kg/cm^2g	according to code	according to code		
38	Tube No.		76			

39		Size	Corr. Allow.	Material	Design Metal Temp.	
40	Oval Headers from Tube	o. d. 108 x 11 thk.	0	16Mo3	370	°C
41	Outer Tube	o. d. 73 x 5,6 thk.	0	16Mo3	350	°C
42	Inner Tube	o. d. 51 x 5 thk.	0	16Mo3	370	°C
43	Downcomer Header	o. d. 8"	3	SA 106M Gr. B	350	°C
44	Riser Header	o. d. 8"	3	SA 106M Gr. B	350	°C
45	Inlet Flange 5)	18", 300 lb, RF	3	16Mo3	450	°C
46	Outlet Flange	14", 300 lb	3	13CrMo4-5	550	°C
47	Inlet Channel/Main Flange	cone 5) / DN 1250	3	16Mo3 / 16Mo3	450/450	°C
48	Outlet Channel/Main Flange	cylindrical / DN 1150	3	13CrMo4-5 / 13CrMo4-5	550	°C
49	Weight empty, approx.: 14.300 kg			Weight with water, approx.:		kg
50	For main dimensions refer to drawing no. 23.10.014-HP-04.0-001-R0					
51	***Remarks***: 1) for clean conditions / 2) refer to mean pressure and mean temperature / 3) under consideration of 1 % heat loss 4) all values without dimensions are in mm / 5) existing cone will be reused					

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ARVOS GmbH SCHMIDTSCHE SCHACK Ellenbacher Straße 10, 34123 Kassel Germany	**Round-Type Transfer Line Exchanger**	ARVOS No.: 23.10.014
	Client: Braskem S. A.	Client No.: PJ-0602056
	Project: Projeto Helius	Spec. No.: N - 3

1	Number of Units 3			Arrangement: vertical upflow		
2	Item No. EA-4107 A/B/C					
3	Operating Case Rating Case 2					
4	**Performance of one Unit**					
5			Shell Side	Tube Side		
6	Fluid		Water / Steam	Furnace Effluent		
7	Total Fluid Entering	kg/h	1)	7.400	Mol. Wt.	23,188
8	Hydrocarbon	kg/h			Mol. Wt.	
9	Hydrogen	kg/h			Mol. Wt.	2,016
10	Steam	kg/h	4.901 1) 3)		Mol. Wt.	18,016
11	Operating Pressure	bar a	120,6	In: 1,32	Out:	1)
12	Operating Temperature	°C	324,8	In: 870	Out: 358	1)
13						
14	Density	kg/m^3				2)
15	Viscosity	cP				2)
16	Spec. Heat	kJ/kg°C				2)
17	Thermal Conductivity	W/m°C				2)
18						
19	Number of Passes		1	1		
20	Mass Velocity	kg/m^2s				
21	Average Velocity	m/s				
22	Pressure Loss (Diff. in Static Press.)	bar		0,035		1)
23	Fouling Resistance	$m^2°C/W$	0,000086	0		
24	Heat Exchanged	kW	1.644,6			1)
25	Heat Transfer Coefficient	$W/m^2°C$				
26	Transfer Rate Service	$W/m^2°C$	Refer to O. D. of Inner Tube			
27	Log. Mean Temp. Diff.	°C				
28	Required Surface	m^2	Refer to O. D. of Inner Tube			
29	Required Tube Length	mm				
30	Installed Tube Length	mm	8.600			
31	Installed Surface	m^2	104,72	Refer to O. D. of Inner Tube		
32	Steam Generated at Sat. Temp.	kg/h	4.901 1) 3)			
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34	**Construction of one Unit** 4)					
35	Design Code		AD 2000	AD 2000		
36	Design Pressure	kg/cm^2g	140,5	3,5		
37	Test Pressure	kg/cm^2g	according to code	according to code		
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40	Oval Headers from Tube	o. d. 108 x 11 thk.	0	16Mo3	370	°C
41	Outer Tube	o. d. 73 x 5,6 thk.	0	16Mo3	350	°C
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43	Downcomer Header	o. d. 8"	3	SA 106M Gr. B	350	°C
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45	Inlet Flange 5)	18", 300 lb, RF	3	16Mo3	450	°C
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47	Inlet Channel/Main Flange	cone 5) / DN 1250	3	16Mo3 / 16Mo3	450/450	°C
48	Outlet Channel/Main Flange	cylindrical / DN 1150	3	13CrMo4-5 / 13CrMo4-5	550	°C
49	Weight empty, approx.: 14.300 kg			Weight with water, approx.:		kg
50	For main dimensions refer to drawing no. 23.10.014-HP-04.0-001-R0					
51	***Remarks***: 1) for clean conditions / 2) refer to mean pressure and mean temperature / 3) under consideration of 1 % heat loss 4) all values without dimensions are in mm / 5) existing cone will be reused					

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ARVOS GmbH SCHMIDTSCHE SCHACK Ellenbacher Straße 10, 34123 Kassel Germany	**Requirements for Water/Steam**	ARVOS No.: 23.10.014
	Client: Braskem S. A.	Client No.: PJ-0602056
	Project: Projeto Helius	Spec. No.: W/S - 1

A	Values recommended by VGB (Vereinigung der Großkesselbesitzer) for steam to turbines, demineralized boiler feed water and boiler water under consideration of alkaline operation method with combined use of volatile (ammonia - NH_3, hydrazine - N_2H_4) and solid (trisodiumphosphate - Na_3PO_4, sodium hydroxide NaOH) alkalizers.
B	Values specified by client.

Requirements	Unit	A	B	Notes
Steam to Turbines				
Conductivity at 25 °C 1)	µS/cm	< 0,2		
Silica	ppm	< 0,02		
Total iron	ppm	< 0,02		
Total copper	ppm	< 0,003		
Sodium	ppm	< 0,01		
Liquid entrainment	Wt. %			
Boiler Feed Water				
Oxygen 4)	ppm	not specified		
Total iron	ppm	< 0,02		
Total copper	ppm	< 0,003		
pH at 25 °C		> 9		
Silica	ppm	< 0,02		
Conductivity at 25 °C 1)	µS/cm	< 0,2		
Boiler Water				
pH at 25 °C		9,5 - 10,5		
Silica 2)	ppm	2)		
Phosphate	ppm	< 6		
Conductivity at 25 °C 1)	µS/cm	< 50 3)		

1) Continuous sampling behind highly acid cation exchanger.
2) Depending on operating pressure.
3) In the event of alkaline operation, only with volatile alkalizers, conductivity in boiler water should not exceed 3 µs/cm.
4) If continuous operation with demineralized water cannot be guaranteed, oxygen content should not exceed 0,02 ppm.

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