A Process Units

The steam networks, steam demand, aero-cooling and water-cooling demands of the units of Sites R and P are presented below. The steam properties are reconciled while the aero-cooling and water-cooling are not. All process data is also available online at [51].

The tables present steam demand, therefore negative values indicate a net import of steam while positive values correspond to what is imported by the Process Units (PUs) from the utility network. Similarly negative heat exchanges correspond to steam generation.

A.1 Site R Process Units

All process requirements are defined using True Boiling Point definitions shown in Tables A.7, A.8 and A.9. For injections, the pressure of the columns are given. This pressure can be used to calculate the minimum injection pressure of the steam.

Turbine isentropic efficiencies are also supplied so as to calculate the steam cogeneration. Their overview is presented in Table A.10.

Losses in the process units of Site R correspond to real physical losses as well as the remains of unexplained steam consumption.

Unit A - Separation

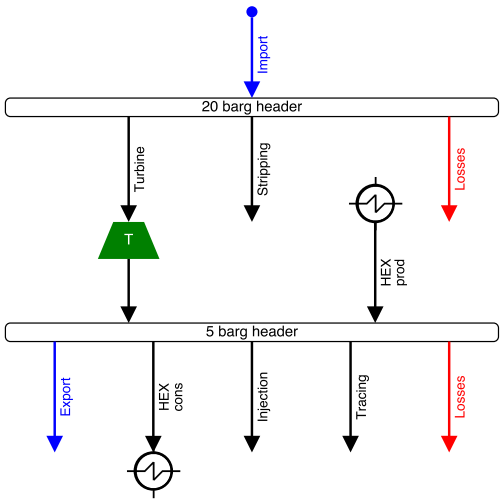

Figure A.1 – Schematic of the steam network of Site R Unit A.

Table A.1 – Steam, cooling demand and mean thermodynamic properties for Site R Unit A.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
20	Import		-10.8	-20.2	-6.2	-11.5				
20	Turbine	Turbo pumps	7.3	14.1	4.2	8.1				30.0
20	Stripping		2.5	4.0	1.4	2.3			9.0	
20	Losses		1.0	4.0	0.6	2.3				
	Total cons.		**10.8**	**20.2**	**6.2**	**11.5**				
5	HEX	Condensation	-5.3	-6.9	-3.2	-4.2	220	205		
5	Export		4.1	10.4	2.5	6.3				
5	HEX	Heating	5.0	16.9	3.0	10.2	110	150		
5	Injection		0.9	1.2	0.5	0.7			0.4	
5	Tracing	Storage tanks	2.0	2.7	1.2	1.6	90	105		
5	Losses		0.5	0.7	0.3	0.4				
	Total cons.		**12.6**	**20.6**	**7.6**	**12.4**				
	Aero cooling	Cooling			19.1	28.7	150	110		
	Water cooling	Cooling			5.3	8.1	100	60		

Unit B - Isomerisation

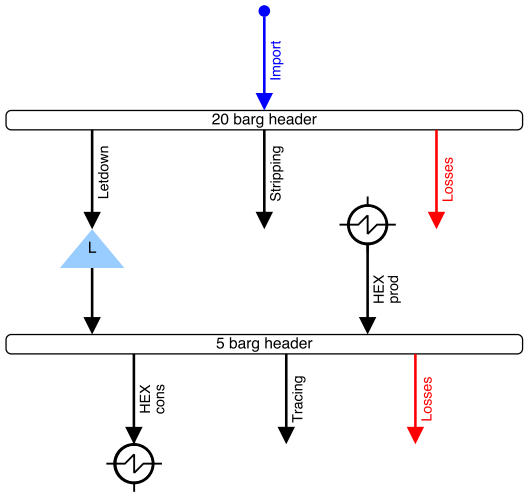

Figure A.2 – Schematic of the steam network of Site R Unit B.

Table A.2 – Steam, cooling demand and mean thermodynamic properties for Site R Unit B.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
20	Import		-10.2	-16.5	-5.8	-9.4				
20	HEX	Evaporation	6.2	11.5	3.6	6.6	170	190		
20	Injection		1.2	1.5	0.7	0.9			5.2	
20	Letdown		2.0	5.7	1.2	3.3				
20	Losses		0.8	1.2	0.5	0.7				
	Total cons.		**10.2**	**16.5**	**5.8**	**9.4**				
5	HEX	Cooling	-5.1	-6.3	-3.1	-3.8	210	187		
5	HEX	Evaporation	5.7	9.6	3.5	5.8	115	125		
5	Losses		0.5	0.5	0.3	0.3				
5	Tracing	Pipe tracing	0.9	1.0	0.5	0.6	90	105		
	Total cons.		**7.1**	**11.0**	**4.3**	**6.6**				
	Aero cooling	Cooling			7.3	10.8	150	110		
	Water cooling	Cooling			5.4	7.8	100	60		

Unit C - Hydrogenation

Comments: Turbines used to compress gases. Reactors produce superheated steam.

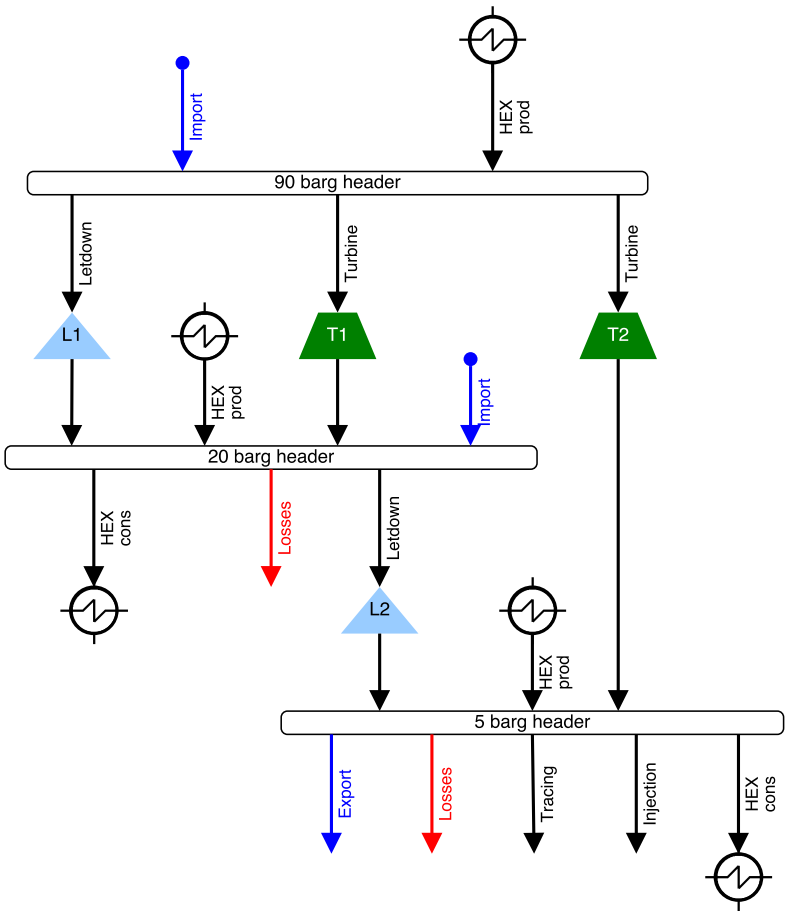

Figure A.3 – Schematic of the steam network of Site R Unit C.

Table A.3 – Steam, cooling demand and mean thermodynamic properties for Site R Unit C.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
90	Import		-13.4	-22.7	-7.3	-12.4				
90	HEX	Reactor cooling	-8.5	-14.3	-4.7	-7.8	550	500		
90	Turbine T1		9.1	18.8	5.0	10.3				40.0
90	Turbine T2		11.9	14.5	6.5	7.9				40.0
90	Letdown L1		1.0	2.1	0.5	1.1				
	Total cons.		**21.9**	**31.4**	**12.0**	**17.2**				
20	Import		-8.9	-19.3	-5.1	-11.1				
20	HEX		-6.0	-31.5	-3.5	-18.0	600	600		
20	HEX	Heating	21.2	31.9	12.1	18.2	150	200		
20	Losses		0.9	1.3	0.5	0.7	375	375		
20	Letdown L2		2.9	17.9	1.6	10.2				
	Total cons.		**25.0**	**36.3**	**14.3**	**20.7**				
5	HEX	Cooling	-7.5	-20.7	-4.5	-12.5	350	300		
5	Export		12.9	28.3	7.8	17.1				
5	HEX	Condensation	3.7	28.3	2.2	17.1	75	115		
5	Injection		2.0	2.8	1.2	1.7			1.0	
5	Losses		1.2	1.7	0.7	1.1				
5	Tracing		2.5	4.0	1.5	2.4	90	105		
	Total cons.		**22.3**	**36.1**	**13.4**	**21.8**				
	Aero cooling	Cooling			15.0	22.5	140	85		
	Water cooling	Cooling			8.8	18.4	125	65		

Unit D - Cracker

Comments: Turbines used for turbo pumps. Reactors produce superheated steam.

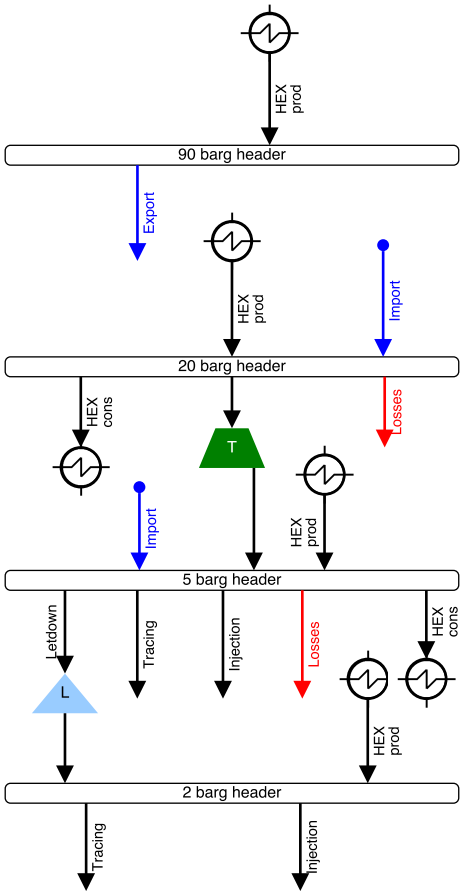

Figure A.4 – Schematic of the steam network of Site R Unit D.

Table A.4 – Steam, cooling demand and mean thermodynamic properties for Site R Unit D.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
90	Export		-12.8	-20.4	-7.0	-11.1				
90	HEX	Catalyser cooling	12.8	20.4	7.0	11.1	615	615		
	Total cons.		**12.8**	**20.4**	**7.0**	**11.1**				
20	Import		-7.5	-18.0	-4.3	-10.3				
20	HEX	Condensation	-10.1	-12.2	-5.8	-7.0	315	290		
20	HEX	Heating	16.1	29.5	9.2	16.9	125	180		
20	Losses		0.5	0.6	0.3	0.3				
20	Turbine		0.9	8.8	0.5	5.0				30.0
	Total cons.		**17.6**	**30.0**	**10.0**	**17.2**				
5	Import		-8.2	-18.6	-4.9	-11.2				
5	HEX	Condensation	-4.9	-18.6	-3.0	-11.2	204	197		
5	HEX	Evaporation	8.2	28.9	4.9	17.4	125	125		
5	Injection		1.4	2.2	0.8	1.3			1.5	
5	Letdown		1.9	3.4	1.1	2.1				
5	Losses		0.4	0.7	0.2	0.4				
5	Tracing	Tank heating	2.1	3.6	1.3	2.2	90	105		
	Total cons.		**14.0**	**34.9**	**8.4**	**21.1**				
2	HEX	Condensation	-1.4	-2.3	-0.9	-1.5	180	180		
2	Injection		0.8	1.5	0.5	0.9			-0.6	
2	Tracing	Pipe tracing	2.5	4.3	1.6	2.7	60	85		
	Total cons.		**3.3**	**5.3**	**2.1**	**3.3**				
	Aero cooling	Cooling			6.2	15.8	180	80		
	Water cooling	Cooling			9.0	26.2	130	65		

Unit E - Separation

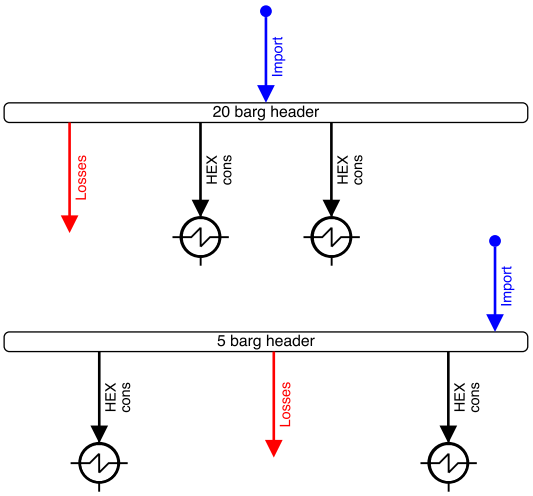

Figure A.5 – Schematic of the steam network of Site R Unit E.

Table A.5 – Steam, cooling demand and mean thermodynamic properties for Site R Unit E.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
20	Import		-19.7	-27.7	-11.3	-15.9				
20	HEX	Evaporation	5.8	7.8	3.3	4.5	160	190		
20	HEX	Heating	13.2	21.4	7.5	12.3	120	170		
20	Losses		0.8	1.2	0.4	0.7				
	Total cons.		**19.7**	**27.7**	**11.3**	**15.9**				
5	Import		-13.4	-19.5	-8.1	-11.8				
5	HEX	Evaporation	4.0	5.3	2.4	3.2	115	115		
5	HEX	Heating	8.6	14.9	5.2	9.0	90	100		
5	Losses		0.7	1.5	0.4	0.9				
	Total cons.		**13.4**	**19.5**	**8.1**	**11.8**				
	Aero cooling	Cooling			3.8	5.2	150	95		
	Water cooling	Cooling			7.2	14.9	110	65		

Unit F - Purification

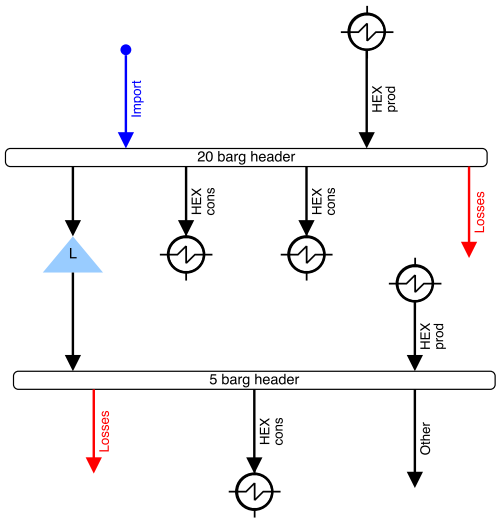

Figure A.6 – Schematic of the steam network of Site R Unit F.

Table A.6 – Steam, cooling demand and mean thermodynamic properties for Site R Unit F.

Level [barg]	Type	Function	Flowrate [t/h] Mean	Flowrate [t/h] Max	Power [MW] Mean	Power [MW] Max	Process [°C] T_{in}	Process [°C] T_{out}	Column [barg]	η [%]
20	Import		-15.8	-27.3	-9.0	-15.6				
20	HEX	Evaporation	5.7	9.3	3.3	5.3	175	175		
20	HEX	Heating	7.7	22.1	4.4	12.6	160	190		
20	Letdown		2.6	7.2	1.5	4.1				
20	Losses		1.0	1.8	0.6	1.0				
20	HEX	Condensation	-1.3	-2.4	-0.7	-1.3	325	295		
	Total cons.		**17.1**	**28.4**	**9.8**	**16.3**				
5	HEX	Condensation	-3.9	-7.3	-2.3	-4.4	218	217		
5	HEX	Evaporation	3.7	6.5	2.2	3.9	116	134		
5	Losses		1.1	2.0	0.7	1.2				
5	Other		1.5	3.1	0.9	1.9				
	Total cons.		**6.4**	**10.7**	**3.8**	**6.5**				
	Aero cooling	Cooling			0.0	0.0	140	85		
	Water cooling	Cooling			12.4	18.4	100	65		

Table A.7 – Mean hot and cold stream data for Site Site R.

Name	Type	P	T_1	Q_1	T_2	Q_2	T_3	Q_3	T_4	Q_4	T_5	Q_5	T_6	Q_6	T_7	Q_7	T_8	Q_8	T_9	Q_9	T_{10}	Q_{10}	
S1A MP strip	Cons	21	180	1.4	180																		
S1A MP loss	Cons	21	25	0.6	26																		
S1A BP inj	Cons	6	110	0.5	110																		
S1A BP trac	Cons	6	65	1.1	65																		
S1A BP loss	Cons	6	25	0.3	26																		
S1A BP chex	Cons	6	63	0.8	63	0.8	110	1.5	112														
S1A BP phex	Prod	6	220	1.0	210	2.2	205																
S1A AERO1	Aero		153	0.5	132	0.5	123	0.5	118	0.5	114	0.5	108	0.5	99	0.5	95	0.5	86	0.5	75	0.5	53
S1A AERO2	Aero		148	0.4	138	0.4	134	0.4	128	0.4	124	0.4	119	0.4	114	0.4	104	0.4	94	0.4	78	0.4	54
S1A AERO3	Aero		130	0.5	120	0.5	114	0.5	113	0.5	104	0.5	100	0.5	93	0.5	84	0.5	61				
S1A AERO3 bis	Aero		178	0.5	152	0.5	130																
S1A AERO4	Aero		146	0.4	139	0.4	133	0.4	125	0.4	112	0.4	106	0.4	93	0.4	77	0.4	46				
S1A AERO4 bis	Aero		189	0.4	160	0.4	146																
S1A AERO5	Aero		75	0.1	69	0.1	66	0.1	64	0.1	63	0.1	62	0.1	59	0.1	58	0.1	55	0.1	52	0.1	45
S1A CW1	CW		145	0.2	143	0.2	142	0.2	141	0.2	141	0.2	141	0.2	141	0.2	140	0.2	140	0.2	139	0.2	138
S1A CW2	CW		65	0.0	40																		
S1A CW3	CW		181	0.3	178	0.3	175	0.3	167														
S1A CW3 bis	CW		208	0.3	199	0.3	191	0.3	188	0.3	186	0.3	185	0.3	182	0.3	181						
S1B MP inj	Cons	21	160	0.5	160																		
S1B MP chex	Cons	21	170	0.9	170	1.5	180	0.6	190														
S1B MP loss	Cons	21	25	0.5	26																		
S1B BP phex	Prod	6	210	0.2	200	0.5	195	0.7	191	1.0	189												
S1B BP trac	Cons	6	85	0.5	85																		
S1B BP loss	Cons	6	25	0.3	26																		
S1B BP chex	Cons	6	115	2.8	115	0.7	125																
S1B AERO1	Aero		78	3.6	45																		
S1B AERO2	Aero		70	1.9	45																		
S1B AERO3	Aero		59	1.8	45																		
S1B CW1	CW		94	2.7	34																		
S1B CW2	CW		120	2.6	29																		
S1C HP phex	Prod	90	550	3.2	550	3.2	500																
S1C MP loss	Prod	90	25	0.5	26																		
S1C MP chex	Cons	21	150	2.3	160	2.3	170	2.3	180	3.5	190	1.2	200										
S1C MP phex	Prod	21	600	3.2	600																		
S1C BP inj	Cons	6	120	1.3	120																		
S1C BP loss	Cons	6	25	0.7	26																		
S1C BP trac	Cons	6	75	1.8	75																		
S1C BP chex	Cons	6	75	0.4	80	0.7	80	0.7	115														
S1C BP phex	Prod	6	350	1.0	340	0.5	330	0.8	320	1.6	310	1.0	305	0.3	300								
S1A MP strip	Cons	21	180	1.4	180																		
S1A MP loss	Cons	21	25	0.6	26																		
S1A BP inj	Cons	6	110	0.5	110																		
S1A BP trac	Cons	6	65	1.1	65																		
S1A BP loss	Cons	6	25	0.3	26																		
S1A BP chex	Cons	6	63	0.8	63	0.8	110	1.5	112														
S1A BP phex	Prod	6	220	1.0	210	2.2	205																

Table A.8 – Mean hot and cold stream data for Site Site R.

Name	Type	P	T_1	Q_1	T_2	Q_2	T_3	Q_3	T_4	Q_4	T_5	Q_5	T_6	Q_6	T_7	Q_7	T_8	Q_8	T_9	Q_9	T_{10}	Q_{10}	
S1A AERO1	Aero		153	0.5	132	0.5	123	0.5	118	0.5	114	0.5	108	0.5	99	0.5	95	0.5	86	0.5	75	0.5	53
S1A AERO2	Aero		148	0.4	138	0.4	134	0.4	128	0.4	124	0.4	119	0.4	114	0.4	104	0.4	94	0.4	78	0.4	54
S1A AERO3	Aero		130	0.5	120	0.5	114	0.5	113	0.5	104	0.5	100	0.5	93	0.5	84	0.5	61				
S1A AERO3 bis	Aero		178	0.5	152	0.5	130																
S1A AERO4	Aero		146	0.4	139	0.4	133	0.4	125	0.4	112	0.4	106	0.4	93	0.4	77	0.4	46				
S1A AERO4 bis	Aero		189	0.4	160	0.4	146																
S1A AERO5	Aero		75	0.1	69	0.1	66	0.1	64	0.1	63	0.1	62	0.1	59	0.1	58	0.1	55	0.1	52	0.1	45
S1A CW1	CW		145	0.2	143	0.2	142	0.2	141	0.2	141	0.2	141	0.2	141	0.2	140	0.2	140	0.2	139	0.2	138
S1A CW2	CW		65	0.0	40																		
S1A CW3	CW		181	0.3	178	0.3	175	0.3	167														
S1A CW3 bis	CW		208	0.3	199	0.3	191	0.3	188	0.3	186	0.3	185	0.3	182	0.3	181						
S1B MP inj	Cons	21	160	0.5	160																		
S1B MP chex	Cons	21	170	0.9	170	1.5	180	0.6	190														
S1B MP loss	Cons	21	25	0.5	26																		
S1B BP phex	Prod	6	210	0.2	200	0.5	195	0.7	191	1.0	189												
S1B BP trac	Cons	6	85	0.5	85																		
S1B BP loss	Cons	6	25	0.3	26																		
S1B BP chex	Cons	6	115	2.8	115	0.7	125																
S1B AERO1	Aero		78	3.6	45																		
S1B AERO2	Aero		70	1.9	45																		
S1B AERO3	Aero		59	1.8	45																		
S1B CW1	CW		94	2.7	34																		
S1B CW2	CW		120	2.6	29																		
S1C HP phex	Prod	90	550	3.2	550	3.2	500																
S1C MP loss	Prod	90	25	0.5	26																		
S1C MP chex	Cons	21	150	2.3	160	2.3	170	2.3	180	3.5	190	1.2	200										
S1C MP phex	Prod	21	600	3.2	600																		
S1C BP inj	Cons	6	120	1.3	120																		
S1C BP loss	Cons	6	25	0.7	26																		
S1C BP trac	Cons	6	75	1.8	75																		
S1C BP chex	Cons	6	75	0.4	80	0.7	80	0.7	115														
S1C BP phex	Prod	6	350	1.0	340	0.5	330	0.8	320	1.6	310	1.0	305	0.3	300								
S1C AERO1	Aero		168	2.2	120																		
S1C AERO2	Aero		214	4.3	140																		
S1C AERO3	Aero		79	3.1	50																		
S1C AERO4	Aero		157	5.3	120																		
S1C CW1	CW		120	0.8	33																		
S1C CW2	CW		140	2.4	94																		
S1C CW3	CW		50	2.0	41																		
S1C CW4	CW		120	4.0	29																		
S1D BP phex	Prod	6	204	2.9	203	0.7	197																
S1D BP chex	Cons	6	125	6.0	125																		
S1D BP loss	Cons	6	25	0.2	26																		
S1D BP inj	Cons	6	127	0.5	127																		

Table A.9 – Mean hot and cold stream data for Site Site R.

Name	Type	P	T_1	Q_1	T_2	Q_2	T_3	Q_3	T_4	Q_4	T_5	Q_5	T_6	Q_6	T_7	Q_7	T_8	Q_8	T_9	Q_9	T_{10}	Q_{10}
S1D BP trac	Cons	6	49	1.1	49																	
S1D MP loss	Cons	6	25	0.3	26																	
S1D MP phex	Prod	21	315	0.6	314	0.6	312	1.2	300	1.8	295	1.8	290									
S1D MP chex	Cons	21	125	0.9	130	0.9	135	1.8	145	1.4	150	0.9	160	1.4	165	0.9	170	0.9	180			
S1D HP phex	Prod	90	615	8.9	615																	
S1D VBP phex	Prod	2	180	1.0	180																	
S1D VBP inj	Cons	2	75	0.6	76																	
S1D VBP trac	Cons	2	60	0.4	70	0.5	80	0.4	85													
S1D AERO1	Aero		130	2.2	45																	
S1D AERO1 bis	Aero		171	1.2	130																	
S1D AERO2	Aero		138	2.8	60																	
S1D CW1	CW		50	0.8	29																	
S1D CW2	CW		79	8.2	45																	
S1E MP chex1	Cons	21	160	0.6	185	1.5	185	0.9	190													
S1E MP losses	Cons	21	25	0.7	26																	
S1E MP chex2	Cons	21	120	0.8	125	1.5	130	1.2	135	0.9	145	1.0	150	0.8	155	0.4	166	1.2	170			
S1E BP chex1	Cons	6	110	1.8	110																	
S1E BP losses	Cons	6	25	0.5	26																	
S1E BP chex2	Cons	6	90	0.6	92	1.1	93	1.7	95	2.0	97	0.3	100									
S1E AERO1	Aero		110	1.5	45																	
S1E AERO2	Aero		114	2.3	45																	
S1E CW	CW		65	7.2	35																	
S1F BP phex	Prod	6	218	1.8	217																	
S1F BP chex	Cons	6	116	0.6	118	1.0	129	0.4	134													
S1F BP loss	Cons	6	25	0.7	26																	
S1F BP other	Cons	6	130	0.8	130																	
S1F MP phex	Prod	21	325	0.2	315	1.0	315	0.1	295													
S1F MP loss	Prod	21	25	0.5	26																	
S1F MP chex2	Cons	21	160	1.1	185	2.3	185	1.1	190													
S1F CW1	CW		73	7.3	44																	
S1F CW2	CW		99	0.9	35																	
S1F CW3	CW		104	2.7	48																	
S1F CW4	CW		93	1.5	29																	
S1U MP trac	Cons	21	160	4.5	180	8.9	180	4.5	190													
S1U BP trac	Cons	6	70	3.7	70																	
S1U1 MP trac	Cons	21	160	0.9	180	1.8	180	0.9	190													
S1U1 BP trac	Cons	6	60	6.9	60																	
S1LOSSES BP	Cons	6	25	2.9	26																	
S1LOSSES MP	Cons	6	25	4.2	26																	
S1U PREMP	Cons	21	110	3.1	150																	
S1U PREBP	Cons	6	25	2.3	110																	
S1U DEGAZ	Cons	6	145	11.4	145																	

Table A.10 – Mean turbine properties for Site R.

Name	P_{in} [barg]	P_{out} [barg]	$\eta[-]$	Steam load $[t/h]$	Power [MW]
S1 SHP HHP TURMP1	90.2	21.0	0.76	84.4	6.79
S1 SHP HHP TURMP2	90.2	21.0	0.41	36.6	2.92
S1 SMP HMP TURUTILS	21.0	6.1	0.35	26.8	0.63
S1A MP turb	21.0	6.1	0.30	7.3	0.15
S1C HP turb BP	90.2	6.1	0.40	11.3	0.77
S1C HP turb MP	90.2	21.0	0.40	9.9	0.42
S1D MP turb	21.0	6.1	0.30	0.3	0.01

A.2 Site P Process Units

All process requirements are defined using True Boiling Point definitions and are shown in Tables A.17 and A.18. For injections, the pressure of the columns are given. This pressure can be used to calculate the minimum injection pressure of the steam.

Turbine isentropic efficiencies are also supplied so as to calculate the steam cogeneration. Their overview is presented in Table A.19.

Losses are not considered inside the process units of Site P.

Unit A - Cracker

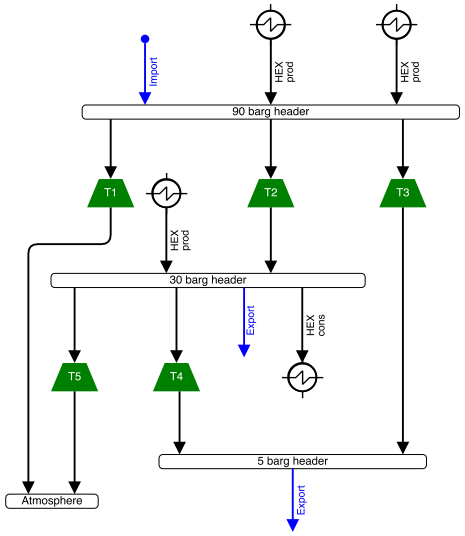

Figure A.7 – Schematic of the steam network of Site P Unit A.