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PROSEC APPLICATION EXAMPLE

SIMULATION OF A BRAZED PLATE FIN HEAT EXCHANGER (BPFHE) WITH CO-PROSEC CAPE-OPEN UNIT OPERATION

LPG RECOVERY UNIT

EXAMPLE PURPOSE
This example shows a brazed plate-fin heat exchanger used in a process of LPG recovery from a natural gas. This heat exchanger is modeled using CO-ProSec, Fives ProSim's CAPE-OPEN compliant unit operation dedicated to the simulation of brazed plate-fin heat exchangers. CO-ProSec allows taking into account the effect of the stacking and of the pressure drop on the enthalpy curves. Regarding the thermodynamic and physico-chemical data needed, two cases are considered: automatically calculated using the thermodynamic calculation server of the process simulation software or given by the user as tabulated data.

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CORRESPONDING PROSEC FILES	*COPROSEC_EX_EN-LPG-Recovery.pmp3*

Reader is reminded that this use case is only an example and should not be used for other purposes. Although this example is based on actual case it may not be considered as typical nor are the data used always the most accurate available. Fives ProSim shall have no responsibility or liability for damages arising out of or related to the use of the results of calculations based on this example.

Energy

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1. PROCESS MODELING

1.1. Process description

This example deals with a brazed plate-fin heat exchanger (BPFHE) used in an LPG (Liquefied Petroleum Gases) recovery process from a natural gas mixture. The main LPG components are hydrocarbons (mainly in the C3-C4 range), propane and butane.

Only one BPFHE can contain more than ten different streams. Thanks to its low cost of production and its high performance (they are generally made of aluminum) it is widely used in cryogenic processes. It will be simulated with CO-ProSec CAPE-OPEN unit operation. The model implemented in this unit operation is a detailed model which takes into account all the complexity of the geometry of this type of heat exchangers. The staking is taken into account. The assumption of common wall temperature is used only in the initialization step.

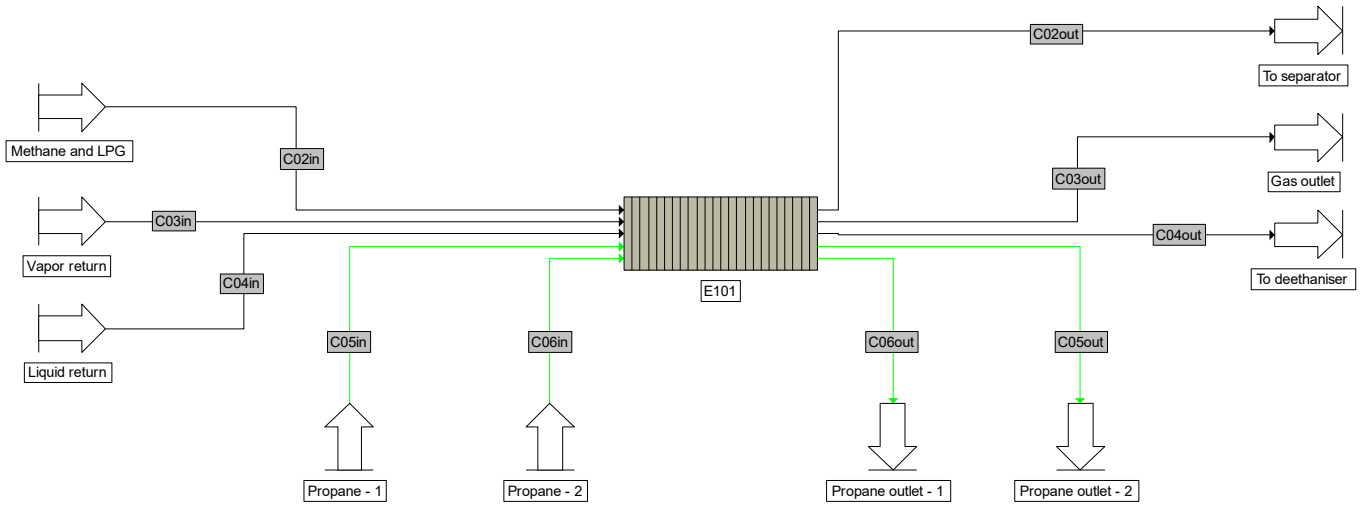
The main gas stream is the stream C02in. This stream is partially condensed in the brazed plate-fin heat exchanger E101. At the heat exchanger outlet, this stream (stream C02out) is sent in a two-phase separator (not considered in this example) to recover methane and ethane. The two outlet streams of the two-phase separator are sent back in the brazed plate-fin heat exchanger as cold streams (streams C03in and C04in). Once treated, the gas (stream C03in) is mainly composed of methane and ethane and flows out of the heat exchanger (stream C03out). The heavies (liquid stream C04in) partially vaporized in the brazed plate-fin heat exchanger are sent in a deethanizer column (not considered in this example). This column is set to recover at the bottom a liquid having the specified mass fraction of methane. The main cold streams of the brazed plate-fin heat exchanger are the two propane streams (C05in and C06in) circulating in a refrigerant closed loop (not considered in this example).

Regarding the thermodynamic and physico-chemical data needed for the simulation, two cases are considered:

- ✓ Automatically calculated by the unit operation: in this example, as the CO-ProSec CAPE-OPEN unit operation is used in ProSimPlus simulation environment, it uses Simulis Thermodynamics, the calculation server for thermophysical properties and phase equilibria calculations available in ProSimPlus.
- ✓ Given by the user as tabulated data calculated before the simulation and outside of the software (using for example Simulis Thermodynamics in Excel or ProPhyPlus).

The example is extracted from [POL89].

1.2. Process flowsheet



1.3. Compounds

The compounds taken into account in the simulation, their chemical formula and CAS numbers are shown in the following table. Their pure component properties are extracted from the standard database provided with ProSimPlus [ROW23].

Compound	Chemical formula	CAS number[1]
Nitrogen	N_2	7727-37-9
Methane	CH_4	74-82-8
Ethane	C_2H_6	74-84-0
Propane	C_3H_8	74-98-6
Isobutane	C_4H_{10}	75-28-5
n-butane	C_4H_{10}	106-97-8
Isopentane	C_5H_{12}	78-78-4
n-pentane	C_5H_{12}	109-66-0
n-hexane	C_6H_{14}	110-54-3
n-heptane	C_7H_{16}	142-82-5

1.4. Thermodynamic model

The thermodynamic model is based on an equation of state approach. The chosen equation of state is the Peng Robinson (PR) [PEN76] model with binary interaction parameters extracted from the ProSimPlus database.

1.5. Tabulated data

If the user doesn't want to use the automatic calculation of the thermodynamic and physico-chemical data needed for the simulation, he can specified them as tabulated values. The following paragraphs present these tabulated data, which have been generated using Simulis Thermodynamics in Excel with the compounds listed in the paragraph 1.3 and the thermodynamic model described in the paragraph 1.4.

[1] *CAS Registry Numbers® are the intellectual property of the American Chemical Society and are used by Fives ProSim SAS with the express permission of ACS. CAS Registry Numbers® have not been verified by ACS and may be inaccurate.*

1.5.1. Stream “Methane and LPG”

	P1 = 833 psi		P2 = 828 psi	
T	ω	H	ω	H
°F	Mass	cal/g	Mass	cal/g
-21	0.6612	-74.251	0.6622	-74.071
-13.95	0.6856	-70.239	0.6864	-70.068
-6.89	0.7089	-66.309	0.7097	-66.143
0.16	0.7317	-62.442	0.7324	-62.281
7.21	0.7540	-58.628	0.7546	-58.471
14.26	0.7759	-54.859	0.7764	-54.706
21.32	0.7975	-51.135	0.7979	-50.985
28.37	0.8186	-47.455	0.8190	-47.307
35.42	0.8392	-43.824	0.8396	-43.679
42.48	0.8591	-40.249	0.8595	-40.106
49.53	0.8782	-36.737	0.8785	-36.597
56.58	0.8962	-33.296	0.8965	-33.159
63.63	0.9130	-29.934	0.9132	-29.800
70.69	0.9285	-26.654	0.9286	-26.523
77.74	0.9427	-23.453	0.9428	-23.326
84.79	0.9557	-20.326	0.9558	-20.203
91.85	0.9677	-17.262	0.9677	-17.142
98.90	0.9789	-14.247	0.9789	-14.131
105.95	0.9896	-11.268	0.9896	-11.155
113.00	1	-8.312	1.0000	-8.201
113.03	1	-8.304	1	-8.191
113.48	1	-8.149	1	-5.783
113.95	1	-7.986	1	-5.622
114.42	1	-7.823	1	-5.460
114.90	1	-7.661	1	-5.298
115.37	1	-7.498	1	-5.136
115.85	1	-7.336	1	-4.975
116.32	1	-7.173	1	-4.813
116.79	1	-7.011	1	-4.651
117.27	1	-6.849	1	-4.490
117.74	1	-6.686	1	-4.328
118.21	1	-6.524	1	-4.167
118.69	1	-6.362	1	-4.005
119.16	1	-6.200	1	-3.844
119.63	1	-6.037	1	-3.683
120.11	1	-5.875	1	-3.521
120.58	1	-5.713	1	-3.360
121.05	1	-5.551	1	-3.199
121.53	1	-5.389	1	-3.038
122	1	-5.227	1	-2.876

Vapor phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-21	4.6156	0.8108	0.0280	0.0212
-13.95	4.5081	0.7847	0.0282	0.0213
-6.89	4.4140	0.7626	0.0284	0.0213
0.16	4.3308	0.7436	0.0286	0.0213
7.21	4.2568	0.7272	0.0288	0.0214
14.26	4.1903	0.7128	0.0290	0.0215
21.32	4.1297	0.7001	0.0292	0.0216
28.37	4.0739	0.6889	0.0295	0.0216
35.42	4.0215	0.6788	0.0297	0.0217
42.48	3.9715	0.6699	0.0300	0.0219
49.53	3.9229	0.6618	0.0302	0.0220
56.58	3.8747	0.6546	0.0304	0.0221
63.63	3.8263	0.6480	0.0307	0.0222
70.69	3.7775	0.6422	0.0309	0.0224
77.74	3.7284	0.6369	0.0312	0.0226
84.79	3.6791	0.6322	0.0315	0.0227
91.85	3.6303	0.6281	0.0317	0.0229
98.90	3.5825	0.6246	0.0320	0.0231
105.95	3.5364	0.6215	0.0322	0.0233
112.90	3.4931	0.6189	0.0325	0.0235
122	3.3992	0.6156	0.0328	0.0238

Liquid phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-21	28.8991	0.6387	0.2500	0.0685
-13.95	29.1793	0.6328	0.2558	0.0682
-6.89	29.4256	0.6281	0.2609	0.0677
0.16	29.6464	0.6242	0.2655	0.0673
7.21	29.8492	0.6211	0.2699	0.0668
14.26	30.0404	0.6185	0.2742	0.0663
21.32	30.2258	0.6163	0.2785	0.0659
28.37	30.4107	0.6142	0.2831	0.0654
35.42	30.5995	0.6123	0.2880	0.0651
42.48	30.7962	0.6105	0.2934	0.0647
49.53	31.0033	0.6087	0.2995	0.0644
56.58	31.2216	0.6069	0.3062	0.0642
63.63	31.4496	0.6051	0.3135	0.0640
70.69	31.6830	0.6034	0.3214	0.0638
77.74	31.9157	0.6020	0.3296	0.0636
84.79	32.1401	0.6009	0.3378	0.0634
91.85	32.3493	0.6003	0.3457	0.0632
98.90	32.5371	0.6001	0.3530	0.0630
105.95	32.6997	0.6004	0.3596	0.0628
112.90	32.8328	0.6011	0.3651	0.0625

1.5.2. Stream “Vapor return”

	P1 = 829 psi		P2 = 808 psi	
T	ϖ	H	ϖ	H
°F	Mass	cal/g	Mass	cal/g
-5.04	1	-48.283	1	-47.506
1.17	1	-45.716	1	-44.981
7.38	1	-43.218	1	-42.519
13.59	1	-40.776	1	-40.111
19.81	1	-38.384	1	-37.747
26.02	1	-36.032	1	-35.422
32.23	1	-33.716	1	-33.131
38.45	1	-31.431	1	-30.868
44.66	1	-29.173	1	-28.629
50.87	1	-26.937	1	-26.413
57.08	1	-24.722	1	-24.215
63.30	1	-22.524	1	-22.033
69.51	1	-20.341	1	-19.865
75.72	1	-18.171	1	-17.710
81.94	1	-16.013	1	-15.564
88.15	1	-13.864	1	-13.428
94.36	1	-11.723	1	-11.299
100.57	1	-9.589	1	-9.176
106.79	1	-7.461	1	-7.059
113	1	-5.338	1	-4.946

Vapor phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-5.04	4.3620	0.7549	0.0284	0.0213
1.17	4.2161	0.7332	0.0285	0.0213
7.38	4.0838	0.7152	0.0286	0.0214
13.59	3.9629	0.6999	0.0287	0.0216
19.81	3.8519	0.6869	0.0289	0.0217
26.02	3.7492	0.6758	0.0290	0.0218
32.23	3.6540	0.6663	0.0292	0.0220
38.45	3.5651	0.6580	0.0293	0.0221
44.66	3.4820	0.6508	0.0295	0.0223
50.87	3.4039	0.6446	0.0297	0.0225
57.08	3.3304	0.6392	0.0299	0.0226
63.30	3.2610	0.6345	0.0301	0.0228
69.51	3.1954	0.6304	0.0303	0.0230
75.72	3.1331	0.6269	0.0305	0.0232
81.94	3.0738	0.6239	0.0307	0.0234
88.15	3.0174	0.6213	0.0309	0.0236
94.36	2.9637	0.6192	0.0311	0.0239
100.57	2.9123	0.6173	0.0313	0.0241
106.79	2.8631	0.6159	0.0315	0.0243
113	2.8159	0.6147	0.0317	0.0245

Liquid phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-5	4.1131	0.7547	0.0284	0.0213
1.21	3.9859	0.7331	0.0285	0.0213
7.43	3.8699	0.7150	0.0286	0.0214
13.64	3.7635	0.6998	0.0287	0.0216
19.85	3.6652	0.6869	0.0289	0.0217

1.5.3. Stream “Liquid return”

	P1 = 829 psi		P2 = 824 psi	
T	ω	H	ω	H
°F	Mass	cal/g	Mass	cal/g
-20.89	0	-113.026	0	-113.030
-20.05	0	-112.744	0	-112.747
-19.21	0	-112.461	0	-112.464
-18.37	0	-112.178	0	-112.181
-17.53	0	-111.894	0	-111.897
-16.69	0	-111.610	0	-111.612
-15.85	0	-111.325	0	-111.327
-15.01	0	-111.039	0	-111.042
-14.17	0	-110.754	0	-110.756
-13.34	0	-110.467	0	-110.470
-12.50	0	-110.180	0	-110.183
-11.66	0	-109.893	0	-109.895
-10.82	0	-109.605	0	-109.607
-9.98	0	-109.317	0	-109.319
-9.14	0	-109.028	0	-109.030
-8.30	0	-108.738	0	-108.740
-7.46	0	-108.448	0	-108.450
-6.62	0	-108.158	0	-108.159
-5.89	0	-107.904	0	-107.906
-5.78	0	-107.867	0.0003	-107.856
-4.94	0	-107.575	0.0024	-107.474
5.78	0.0255	-102.746	0.0277	-102.650
16.50	0.0490	-97.988	0.0510	-97.897
27.22	0.0714	-93.254	0.0734	-93.165
37.95	0.0936	-88.506	0.0955	-88.417
48.67	0.1161	-83.714	0.1179	-83.625
59.39	0.1395	-78.854	0.1413	-78.762
70.11	0.1643	-73.902	0.1662	-73.807
80.83	0.1912	-68.841	0.1931	-68.742
91.56	0.2205	-63.654	0.2224	-63.549
102.28	0.2528	-58.327	0.2548	-58.215
113	0.2886	-52.848	0.2907	-52.729

Vapor phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-4.84	4.3597	0.7543	0.0284	0.0213
5.88	4.2829	0.7312	0.0287	0.0213
16.60	4.2311	0.7126	0.0291	0.0214
27.32	4.2013	0.6977	0.0295	0.0215
38.05	4.1911	0.6856	0.0299	0.0216
48.77	4.1987	0.6760	0.0304	0.0217
59.49	4.2228	0.6685	0.0308	0.0218
70.21	4.2623	0.6629	0.0312	0.0218
80.93	4.3163	0.6588	0.0317	0.0219
91.66	4.3837	0.6563	0.0322	0.0220
102.38	4.4636	0.6552	0.0326	0.0221
113.1	4.5551	0.6552	0.0331	0.0222

Liquid phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-20.89	30.4344	0.6050	0.2897	0.0712
-20.05	30.3882	0.6061	0.2882	0.0710
-19.21	30.3419	0.6071	0.2868	0.0709
-18.37	30.2954	0.6081	0.2853	0.0707
-17.53	30.2488	0.6092	0.2839	0.0705
-16.69	30.2021	0.6103	0.2825	0.0703
-15.85	30.1553	0.6113	0.2810	0.0701
-15.01	30.1083	0.6124	0.2796	0.0699
-14.17	30.0612	0.6135	0.2782	0.0697
-13.34	30.0139	0.6146	0.2768	0.0695
-12.50	29.9665	0.6157	0.2754	0.0693
-11.66	29.9190	0.6168	0.2740	0.0691
-10.82	29.8713	0.6179	0.2727	0.0690
-9.98	29.8234	0.6191	0.2713	0.0688
-9.14	29.7754	0.6202	0.2699	0.0686
-8.30	29.7273	0.6214	0.2686	0.0684
-7.46	29.6790	0.6225	0.2672	0.0682
-6.62	29.6305	0.6237	0.2659	0.0680
-5.78	29.5818	0.6249	0.2646	0.0678
-4.94	29.5330	0.6261	0.2632	0.0677
5.78	29.5416	0.6280	0.2612	0.0663
16.50	29.4912	0.6316	0.2579	0.0650
27.22	29.3936	0.6366	0.2537	0.0636
37.95	29.2576	0.6426	0.2489	0.0623
48.67	29.0901	0.6497	0.2436	0.0609
59.39	28.8964	0.6575	0.2381	0.0596
70.11	28.6810	0.6661	0.2325	0.0584
80.83	28.4478	0.6753	0.2270	0.0572
91.56	28.2002	0.6851	0.2215	0.0560
102.28	27.9412	0.6953	0.2161	0.0550
113	27.6741	0.7059	0.2110	0.0539

1.5.4. Streams “Propane – 1” and “Propane – 2”

	P1 = 31 psi		P2 = 30 psi	
T	ω	H	ω	H
°F	Mass	cal/g	Mass	cal/g
-20.89	0	-119.656	0	-119.657
-20.42	0	-119.515	0	-119.516
-19.94	0	-119.374	0	-119.376
-19.47	0	-119.234	0	-119.235
-19.00	0	-119.093	0	-119.094
-18.52	0	-118.952	0	-118.953
-18.05	0	-118.810	0	-118.812
-17.57	0	-118.669	0	-118.670
-17.10	0	-118.528	0	-118.529
-16.63	0	-118.386	0	-118.387
-16.15	0	-118.245	0	-118.246
-15.68	0	-118.103	0	-118.104
-15.21	0	-117.961	0	-117.962
-14.73	0	-117.819	0	-117.820
-14.26	0	-117.677	0	-117.678
-13.79	0	-117.534	0	-117.535
-13.49	0	-117.446	0	-117.447
-13.31	0	-117.392	0.0208	-115.365
-12.84	0	-117.249	0.0947	-108.046
-12.36	0	-117.107	0.2101	-96.688
-11.89	0	-116.964	0.3819	-79.881
-11.27	0.0897	-108.076	0.6389	-54.815
-10.65	0.2493	-92.422	0.8322	-35.960
-10.03	0.4963	-68.347	0.9582	-23.672
-9.41	0.7329	-45.325	1	-19.518
-8.79	0.8941	-29.641	1	-19.395
-8.17	1	-19.330	1	-19.272
-1.32	1	-17.962	1	-17.905
5.53	1	-16.581	1	-16.525
12.38	1	-15.186	1	-15.132
19.23	1	-13.777	1	-13.725
26.08	1	-12.355	1	-12.303
32.94	1	-10.918	1	-10.868
39.79	1	-9.467	1	-9.417
46.64	1	-8.000	1	-7.952
53.49	1	-6.519	1	-6.472
60.34	1	-5.023	1	-4.977
67.19	1	-3.511	1	-3.466
74.04	1	-1.984	1	-1.940
80.89	1	-0.441	1	-0.398
87.74	1	1.117	1	1.160
94.60	1	2.692	1	2.733
101.45	1	4.282	1	4.322
108.30	1	5.888	1	5.928
115.15	1	7.510	1	7.549
122	1	9.148	1	9.186

Vapor phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-11.79	0.2979	0.3565	0.0167	0.0083
-11.17	0.2989	0.3566	0.0167	0.0083
-10.55	0.2997	0.3568	0.0167	0.0083
-9.93	0.3002	0.3570	0.0167	0.0083
-9.31	0.3005	0.3572	0.0167	0.0083
-8.69	0.3006	0.3575	0.0167	0.0083
-8.07	0.3006	0.3578	0.0167	0.0083
-1.22	0.2953	0.3612	0.0170	0.0085
5.63	0.2903	0.3647	0.0172	0.0087
12.48	0.2854	0.3683	0.0175	0.0089
19.33	0.2808	0.3719	0.0177	0.0091
26.18	0.2762	0.3757	0.0180	0.0094
33.04	0.2719	0.3795	0.0182	0.0096
39.89	0.2677	0.3833	0.0185	0.0098
46.74	0.2636	0.3872	0.0188	0.0101
53.59	0.2597	0.3912	0.0190	0.0103
60.44	0.2558	0.3952	0.0193	0.0105
67.29	0.2521	0.3993	0.0195	0.0108
74.14	0.2485	0.4033	0.0198	0.0110
80.99	0.2451	0.4074	0.0200	0.0113
87.84	0.2417	0.4116	0.0203	0.0115
94.70	0.2384	0.4157	0.0205	0.0118
101.55	0.2352	0.4199	0.0208	0.0121
108.40	0.2321	0.4241	0.0211	0.0124
115.25	0.2291	0.4283	0.0213	0.0126
122.10	0.2262	0.4325	0.0216	0.0129

Liquid phase				
T	ρ	Cp	μ	λ
°F	lb/ft3	cal/g/K	lb/ft/h	Btu/ft/h/F
-20.89	34.9465	0.5340	0.4123	0.0731
-20.42	34.9259	0.5344	0.4111	0.0730
-19.94	34.9053	0.5349	0.4099	0.0729
-19.47	34.8846	0.5353	0.4087	0.0728
-19.00	34.8640	0.5358	0.4075	0.0727
-18.52	34.8433	0.5363	0.4064	0.0726
-18.05	34.8226	0.5367	0.4052	0.0725
-17.57	34.8020	0.5372	0.4040	0.0724
-17.10	34.7813	0.5377	0.4028	0.0723
-16.63	34.7606	0.5381	0.4017	0.0723
-16.15	34.7399	0.5386	0.4005	0.0722
-15.68	34.7191	0.5391	0.3995	0.0721
-15.21	34.6984	0.5395	0.3983	0.0720
-14.73	34.6777	0.5400	0.3972	0.0719
-14.26	34.6569	0.5405	0.3961	0.0718
-13.79	34.6361	0.5410	0.3949	0.0717
-13.31	34.6154	0.5415	0.3938	0.0716
-12.84	34.5946	0.5419	0.3926	0.0715
-12.36	34.5738	0.5424	0.3915	0.0714
-11.89	34.5530	0.5429	0.3904	0.0713
-11.27	34.5452	0.5432	0.3898	0.0712
-10.65	34.5429	0.5434	0.3894	0.0710
-10.03	34.5536	0.5433	0.3896	0.0709
-9.41	34.5791	0.5430	0.3905	0.0708
-8.79	34.6120	0.5426	0.3917	0.0706
-8.27	34.6415	0.5422	0.3928	0.0705

1.6. Operating parameters

1.6.1. Process feed

	Methane and LPG	Vapor retrun	Liquid return	Propane - 1 Propane - 2
Temperature (°F)	113	-5		Bubble temperature
Pressure (psi)	833	829		31
Total flow rate (lb/h)	25 450	18 215	7 236	3 070
Mass fractions				
Nitrogen	0.000235	0.000318	0.000026	0
Methane	0.608936	0.780905	0.176034	0
Ethane	0.101003	0.098790	0.106575	0.006574
Propane	0.142075	0.087232	0.280131	0.966526
Isobutane	0.039877	0.014381	0.104059	0.022367
n-butane	0.043558	0.012766	0.121071	0.004533
Isopentane	0.018874	0.002923	0.059027	0
n-pentane	0.012827	0.001777	0.040646	0
n-hexane	0.012997	0.000562	0.044298	0
n-heptane	0.019618	0.000346	0.068133	0

1.6.2. Brazed plate-fin heat exchanger E101

✓ General parameters

Parameters	Value
Type of exchanger	ProSec
Number of body	1
Orientation	Horizontal
Fin data base	2011 -> Now
Material	Aluminium TRANE
Used width (in)	12
Thickness of the side bars (in)	1
Thickness of the end bars (in)	0.25
Thickness of the separation plates (in)	0.1
Thickness of the closing plates (in)	0.1

✓ Streams parameters

	Stream				
Parameter	**C02**	**C03**	**C04**	**C05**	**C06**
Flow direction	From top to bottom	From bottom to top			
Heat exchange correlation	HTFS85				
Pressure drop	Taken into account				
Maximum pressure drop (psi)	5	21	5	1	1
Other parameters	Default parameters				

✓ Fins characteristics

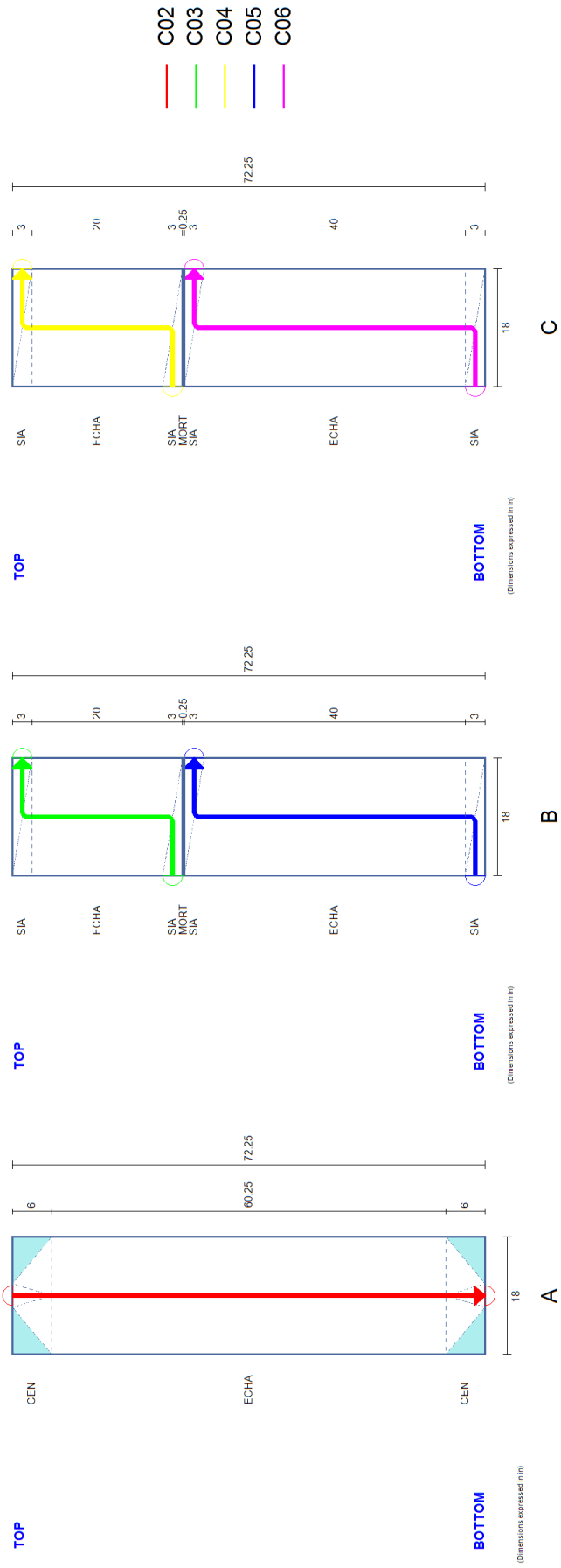
Name	Fin #1	Fin #2	Fin #3
Origin	User		
Calculation mode	From geometry		
Reference	2848	2858	2923
Type	Serrated		Perforated
Height (in)	0.25		0.25
Thickness (in)	0.016		0.010
Fins number per meter	669	748	551
Porosity (%)	-		5
Serration length (in)	0.125		-
Other parameters	Default parameters		

✓ Reference passages

The fins used for each stream are shown in the table below:

Stream	**Fin**
C02	Fin #1
C03	Fin #1
C04	Fin #2
C05	Fin #3
C06	Fin #3
“MORT” elementary zone	Fin #1

The following figure shows the three reference passages of the heat exchanger. Dimensions are expressed in inch.

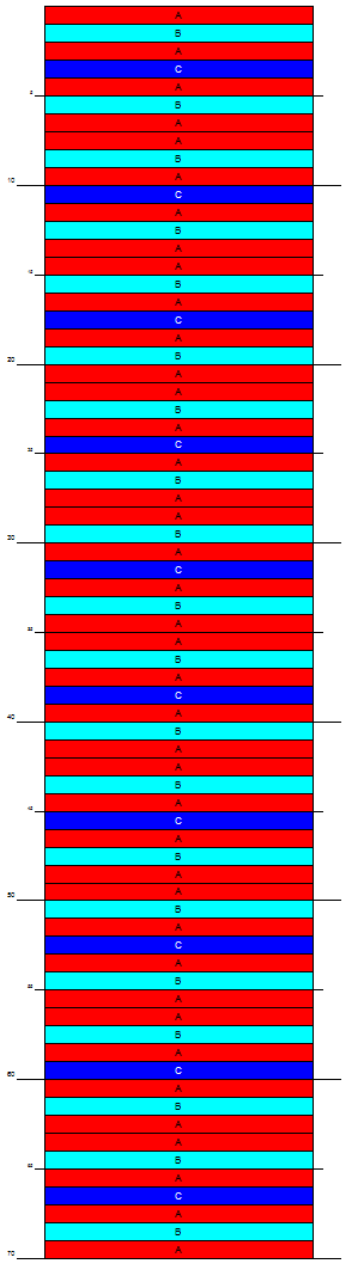


The characteristcis of the distributors are displayed in the following table:

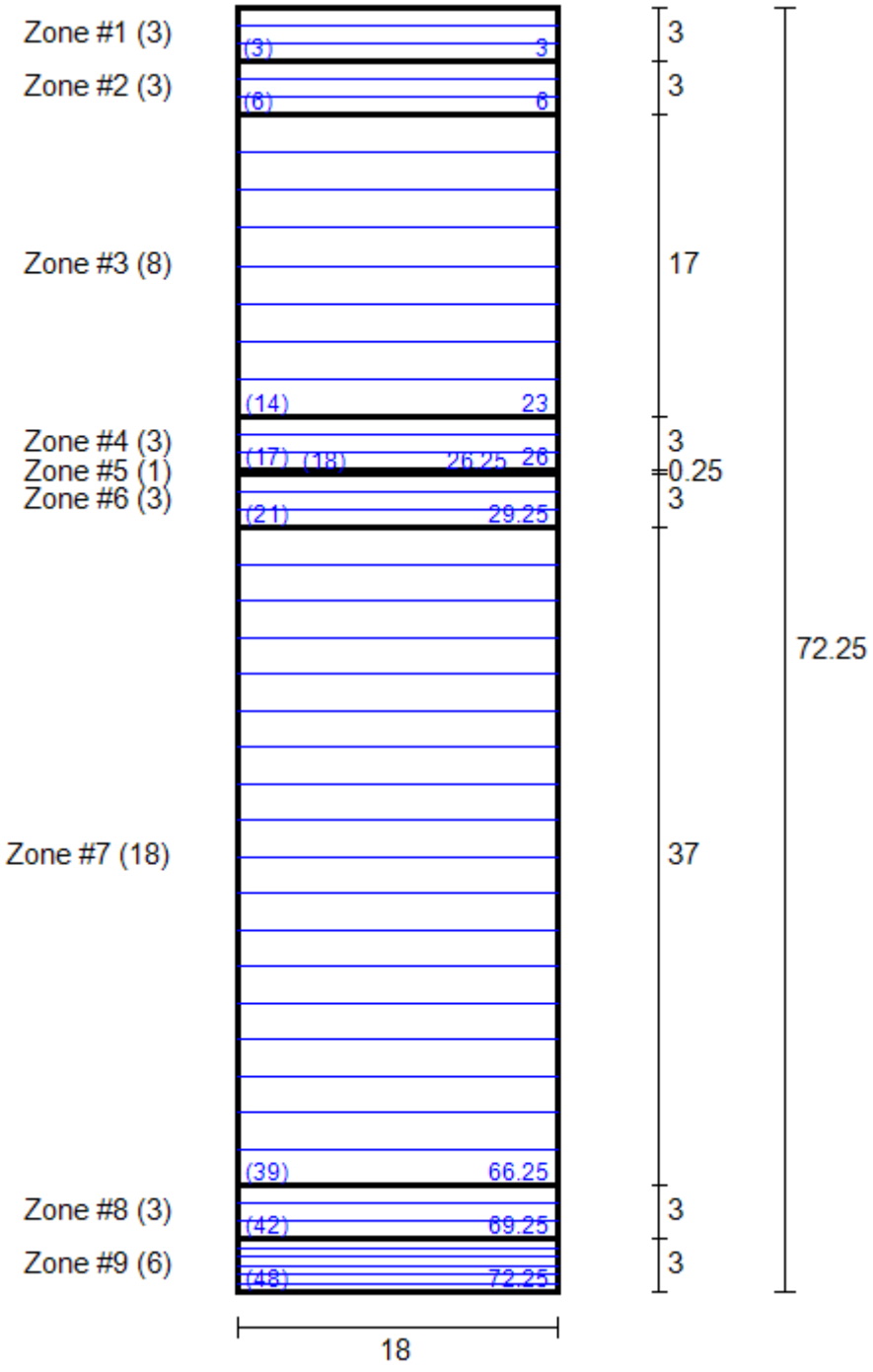
	Distributor type	
Parameter	**CEN**	**SIA**
Opening (in)	3	3
Height (in)	6	3
Head height (in)	1.5	1.5

✓ Stacking

Parameters	Value
Number of repetitions of the sequence	10
Sequence	A B A C A B A



✓ Number of meshs for each elementary zone (dimensions are expressed in inch)



2. RESULTS

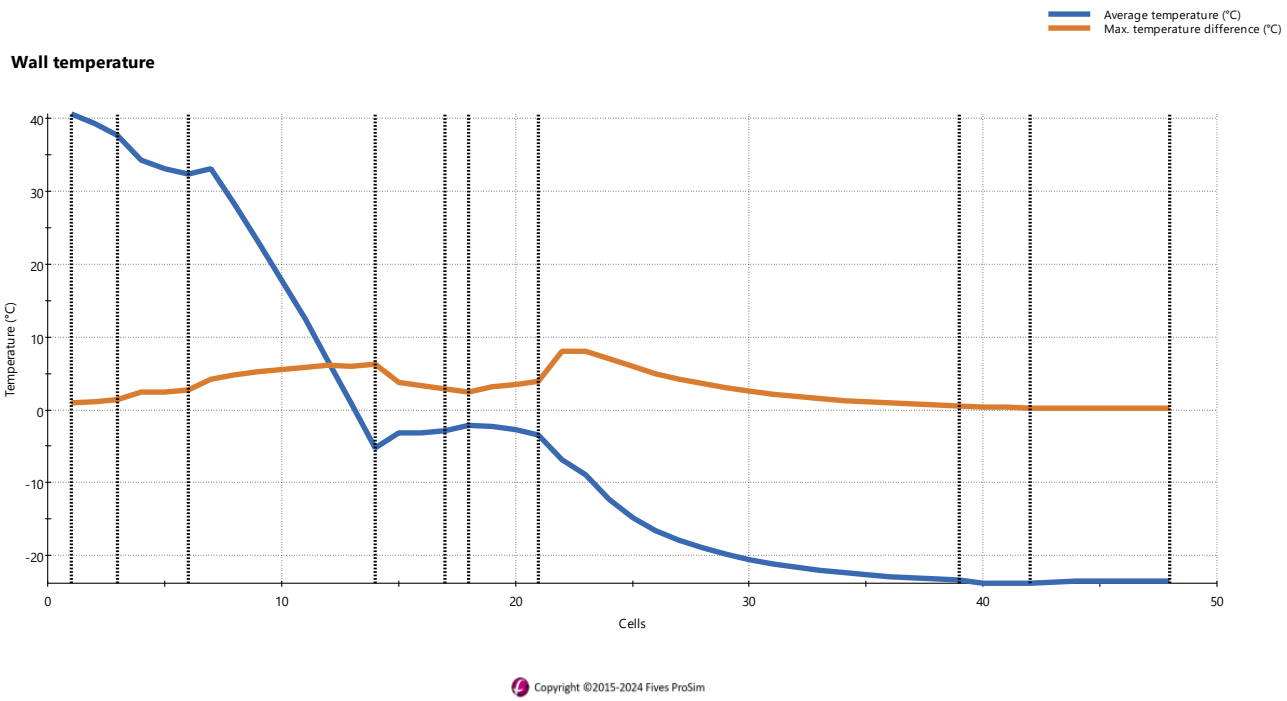
The results of the two cases being close, only the ones from the automatic calculations of the thermodynamic and physico-chemical are presented.

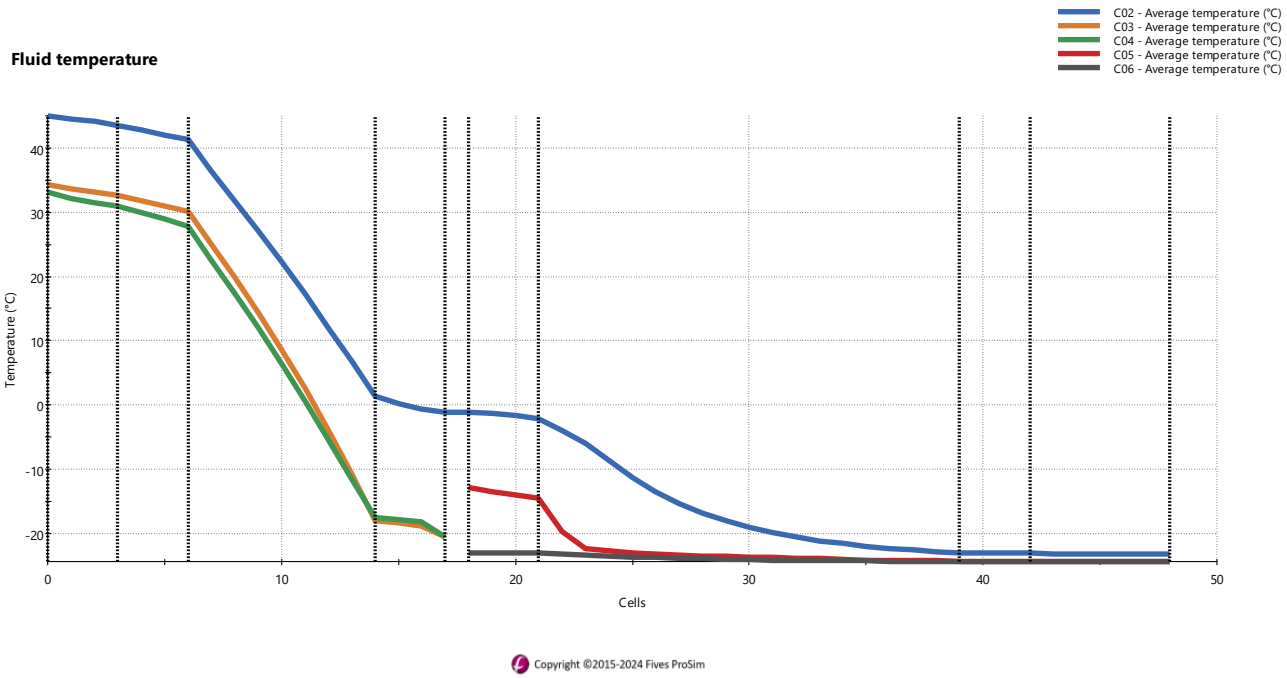
2.1. Mass and energy balances

Streams		C02out	C03out	C04out	C05out	C06out
From		E101	E101	E101	E101	E101
To		To separator	Gas outlet	To deethani...	Propane out...	Propane out...
Partial flows (mass)		lb/h	lb/h	lb/h	lb/h	lb/h
NITROGEN		6.0018	5.8116	0.18829	0	0
METHANE		15497	14224	1273.8	0	0
ETHANE		2570.5	1799.5	771.17	20.183	20.183
PROPANE		3615.8	1588.9	2027	2967.2	2967.2
ISOBUTANE		1014.9	261.93	752.97	68.669	68.669
n-BUTANE		1108.6	232.5	876.07	13.917	13.917
ISOPENTANE		480.3	53.211	427.12	0	0
n-PENTANE		326.41	32.371	294.12	0	0
n-HEXANE		330.79	10.265	320.55	0	0
n-HEPTANE		499.25	6.2661	493	0	0
Total flow (mass)	lb/h	25450	18215	7236	3070	3070
Mass fractions						
NITROGEN		0.00023583	0.00031906	2.6021E-005	0	0
METHANE		0.60894	0.78091	0.17604	0	0
ETHANE		0.101	0.09879	0.10657	0.0065741	0.0065741
PROPANE		0.14208	0.087231	0.28013	0.96653	0.96653
ISOBUTANE		0.039877	0.01438	0.10406	0.022368	0.022368
n-BUTANE		0.043558	0.012764	0.12107	0.0045332	0.0045332
ISOPENTANE		0.018872	0.0029213	0.059027	0	0
n-PENTANE		0.012826	0.0017771	0.040646	0	0
n-HEXANE		0.012998	0.00056353	0.044299	0	0
n-HEPTANE		0.019617	0.00034401	0.068131	0	0
Physical state		Liq./Vap.	Vapor	Liq./Vap.	Vapor	Liq./Vap.
Temperature	°F	-9.7201	92.622	89.967	7.725	-9.5255
Pressure	psi	828.63	808.76	824.9	30.728	30.324
Enthalpic flow	Btu/h	-3.1038E006	-3.9051E005	-8.3827E005	-89293	-1.3246E005
Molar vapor fraction		0.8216	1	0.34056	1	0.95549

2.2. Brazed plate-fin heat exchanger E101 profiles

Several profiles (wall temperature, fluid temperature, pressure, heat transfer coefficient, vaporization ratio, etc.) in the heat exchanger are available after the simulation from ProSec edition window (“Results” tab). The following figures show the wall temperature profiles (average and maximal deviation) and the fluid mean temperature profiles along the length of the heat exchanger.





3. REFERENCES

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