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APPENDICES

Appendix A Experimental Data of Microemulsion Formation

1. Interfacial Tension (IFT)

The interfacial tension of each phase of microemulsion is interpreted by the following formulation:

$$IFT = e(Vd)^3 n^2 \Delta\rho \qquad (A1)$$

where

σ = interfacial tension or IFT (mN/m, dyne/cm)

e = unity factor ($3.427*10^{-7}$ mN cm^3 min^2 /m g mm^3)

V = enlargement factor (0.31 mm/sdv)

d = measured drop diameter (sdv)

n = number of revolution (1/min)

$\Delta\rho$ = density difference of two liquids (g/cm^3)

2. Experimental Data of Interfacial Tension (IFT)

2.1 Interfacial Tension

Table A1 Interfacial tension of each phase in microemulsion formation at different Alfoterra concentration with 5 wt.% NaCl and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	5	1	0.8728	1.0311	4.890	2.925	451	0.00249
		2			4.870	2.960	486	0.00266
		3			4.840	3.010	516	0.00264
		4			4.870	3.055	478	0.00221
		5			4.835	3.080	507	0.00225
		ave						0.00245
1.0	5	1	0.8741	1.0251	4.430	3.290	264	0.00016
		2			4.430	3.160	262	0.00022
		3			4.450	3.260	347	0.00031
		4			4.390	3.270	409	0.00036
		5			4.350	3.380	309	0.00013
		ave						0.00024
1.5	5	1	0.8740	1.0289	4.975	2.570	366	0.00295
		2			4.955	2.640	432	0.00366
		3			4.950	2.650	395	0.00300
		4			4.930	2.700	468	0.00384
		5			4.890	2.790	532	0.00415
		6			4.920	2.730	450	0.00336
		ave						0.00349

Table A2 Interfacial tension of each phase in microemulsion formation with 0.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	2	1	0.8740	1.0024	4.870	2.740	1302	0.02147
		2			4.860	2.750	1391	0.02383
		3			4.850	2.760	1422	0.02420
		4			4.830	2.800	1613	0.02853
		5			4.845	2.775	1527	0.02711
		6			4.840	2.755	1385	0.02279
		ave						0.02466
	3	1	0.8808	1.0214	5.240	2.490	701	0.01467
		2			5.240	2.500	727	0.01561
		3			5.220	2.525	763	0.01636
		4			5.220	2.520	738	0.01539
		5			5.200	2.540	863	0.01661
		ave						0.01573
	4	1	0.8736	1.0318	5.090	2.615	379	0.00352
		2			5.095	2.730	413	0.00364
		3			5.080	2.850	450	0.00363
		4			5.055	2.905	475	0.00362
		5			5.035	2.940	514	0.00392
		6			4.970	2.940	541	0.00395
		7			4.905	3.160	597	0.00306
		ave						0.00362
	5	1	0.8728	1.0311	4.890	2.925	451	0.00249
		2			4.870	2.960	486	0.00266
		3			4.840	3.010	516	0.00264

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	5	4	0.8728	1.0311	4.870	3.055	478	0.00221
		5			4.835	3.080	507	0.00225
		ave						0.00245
	6	1	0.8705	1.0338	5.140	2.505	1040	0.03299
		2			5.105	2.520	1125	0.03645
		3			5.080	2.550	1218	0.04005
		4			5.100	2.545	1080	0.03243
		5			5.055	2.585	1174	0.03463
		6			5.025	2.620	1279	0.03794
		ave						0.03575
	8	1	0.8756	1.0584	5.075	2.530	1217	0.04556
		2			5.065	2.560	1292	0.04897
		3			5.045	2.585	1394	0.05399
		4			5.070	2.580	1323	0.05043
		5			5.045	2.615	1450	0.05630
		ave						0.05105
	9	1	0.8756	1.0710	5.04	2.525	1324	0.05563
		2			5.02	2.525	1384	0.05935
		3			5.04	2.51	1264	0.05162
		4			5.035	2.535	1346	0.05647
		5			5.02	2.535	1422	0.06190
		ave						0.05699

Table A3 Interfacial tension of each phase in microemulsion formation with 1 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1	2	1	0.8733	1.0080	5.420	2.235	975	0.04224
		2			5.400	2.290	1050	0.04561
		3			5.430	2.215	942	0.04055
		4			5.395	2.265	1025	0.04430
		5			5.350	2.320	1139	0.04963
		ave						0.04447
	3	1	0.8751	1.0136	5.035	2.560	843	0.01523
		2			5.020	2.615	914	0.01643
		3			5.070	2.485	814	0.01618
		4			5.040	2.530	878	0.01724
		5			5.035	2.580	941	0.01853
		ave						0.01672
	5	1	0.8741	1.0251	4.430	3.290	264	0.00016
		2			4.430	3.160	262	0.00022
		3			4.450	3.260	347	0.00031
		4			4.390	3.270	409	0.00036
		5			4.350	3.380	309	0.00013
		ave						0.00024
	6	1	0.8754	1.0257	5.250	2.430	945	0.03073
		2			5.225	2.450	994	0.03240
		3			5.220	2.480	1045	0.03447
		4			5.250	2.425	913	0.02884
		5			5.150	2.560	1176	0.03687
		ave						0.03266

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1	10	1	0.8776	1.0512	5.320	2.260	1248	0.07909
		2			5.325	2.200	1325	0.09496
		3			5.330	2.220	1276	0.08680
		4			5.305	2.340	1436	0.09526
		5			5.215	2.285	1588	0.11242
		ave						0.09371

Table A4 Interfacial tension of each phase in microemulsion formation with 1.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1.5	2	1	0.8771	0.9978	5.600	2.065	1021	0.05674
		2			5.530	2.145	1160	0.06431
		3			5.635	2.005	932	0.05120
		4			5.485	2.205	1258	0.06882
		5			5.660	1.960	859	0.04606
		ave						0.05743
	4	1	0.8759	1.0180	4.780	2.750	385	0.00180
		2			4.770	2.750	402	0.00193
		3			4.770	2.770	483	0.00271
		4			4.770	2.785	560	0.00356
		5			4.760	2.810	670	0.00483
		6			4.745	2.840	762	0.00582
		7			4.680	2.910	1024	0.00844
		ave						0.00416
	5	1	0.8740	1.0289	4.975	2.570	366	0.00295
		2			4.955	2.640	432	0.00366
		3			4.950	2.650	395	0.00300
		4			4.930	2.700	468	0.00384
		5			4.890	2.790	532	0.00415
		6			4.920	2.730	450	0.00336
		ave						0.00349

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	No.	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1.5	6	1	0.8758	1.0396	5.265	2.355	637	0.01672
		2			5.200	2.480	769	0.01990
		3			5.300	2.310	532	0.01265
		4			5.235	2.420	654	0.01596
		5			5.280	2.365	573	0.01360
		ave						0.01577
	7	1	0.8755	1.0414	4.965	2.615	1351	0.04012
		2			5.005	2.570	1161	0.03296
		3			4.990	2.590	1230	0.03542
		4			4.970	2.620	1336	0.03923
		5			4.940	2.650	1443	0.04235
		ave						0.03802
	10	1	0.8804	1.0847	5.030	2.605	2207	0.14488
		2			5.150	2.400	1100	0.05249
		3			5.135	2.440	1364	0.07596
		4			5.120	2.445	1484	0.08792
		5			5.090	2.495	1725	0.10846
		6			5.070	2.515	1878	0.12270
		7			5.140	2.420	1299	0.07083
		8			5.040	2.560	2100	0.14030
		ave						0.10044

2.2 Dynamic Interfacial Tension

Table A5 Dynamic interfacial tension of each phase in microemulsion formation with 0.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	2	0	0.8762	1.0196	5.130	2.420	1423	0.05900
		5			5.140	2.410	1423	0.06032
		10			5.140	2.420	1424	0.06007
		15			5.150	2.420	1427	0.06066
		20			5.150	2.420	1425	0.06016
		25			5.140	2.420	1428	0.06041
		30			5.160	2.440	1429	0.05983
		35			5.140	2.430	1428	0.05942
		40			5.120	2.410	1429	0.05950
		45			5.140	2.390	1431	0.06201
		50			5.130	2.400	1430	0.06091
	3	0	0.8762	1.0159	5.570	2.220	1059	0.06014
		5			5.570	2.310	1058	0.05532
		10			5.400	2.200	1059	0.05242
		15			5.390	2.180	1060	0.05301
		20			5.410	2.170	1060	0.05451
		25			5.440	2.150	1061	0.05718
		30			5.450	2.140	1059	0.05801
	4	0	0.8762	1.0286				
		5						
		10			4.770	2.780	2972	0.10830
		15			4.580	2.980	2972	0.05629

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	4	20	0.8762	1.0286	4.160	3.360	2972	0.00704
		25			4.130	3.340	2972	0.00678
		30			4.150	3.320	2972	0.00786
		35			4.130	3.320	2972	0.00730
	5	0	0.8762	1.0340	4.900	2.350	394	0.00415
		5			4.890	2.360	395	0.00407
		10			4.880	2.355	395	0.00405
		15			4.875	2.355	395	0.00402
		20			4.880	2.355	395	0.00405
		25			4.870	2.350	395	0.00402
		30			4.870	2.350	395	0.00402
		35			4.875	2.355	395	0.00402
	6	0	0.8762	1.0371	5.280	2.010	1584	0.14413
		5			5.140	2.200	1585	0.10488
		10			4.770	2.630	1588	0.04060
		15			4.690	2.750	1586	0.03017
		20			4.610	2.820	1586	0.02370
		25			4.590	2.850	1587	0.02180
		30			4.580	2.870	1588	0.02072
		35			4.590	2.860	1588	0.02145
		40			4.580	2.860	1586	0.02103
		45			4.580	2.850	1586	0.02140
		50			4.530	2.870	1585	0.01888
	8	0	0.8762	1.0576	4.940	2.670	1872	0.07642
		5			4.920	2.730	1873	0.06824
		10			4.880	2.730	1872	0.06450
		15			4.860	2.740	1872	0.06184
		20			4.860	2.770	1875	0.05944

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
0.5	9	0	0.8762	1.0548	5.930	1.330	1280	0.29072
		5			5.430	2.120	1279	0.10815
		10			5.390	2.150	1279	0.10143
		15			5.320	2.130	1280	0.09696
		20			5.290	2.150	1280	0.09247
		25			5.260	2.180	1280	0.08727
		30			5.240	2.230	1279	0.08133
		35			5.120	2.310	1280	0.06627
		40			4.930	2.370	1280	0.05011
		45			4.880	2.410	1281	0.04508
		50			4.960	2.190	1281	0.06358
	10	0	0.8762	1.0653	5.660	1.560	695	0.06441
		5			5.530	1.620	809	0.07552
		10			5.540	1.640	809	0.07494
		15			5.560	1.650	809	0.07552
		20			5.550	1.660	810	0.07455
		25			5.560	1.650	809	0.07552
		30			5.560	1.640	810	0.07629
		35			5.550	1.650	810	0.07513
		40			5.510	1.590	809	0.07610
		45			5.530	1.600	810	0.07688
		50			5.550	1.640	810	0.07571

Table A6 Dynamic interfacial tension of each phase in microemulsion formation with 1 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1	2	0	0.8762	1.0178	6.140	1.130	724	0.09532
		5			6.150	1.160	724	0.09418
		10			6.170	1.170	724	0.09475
		15			6.150	1.170	724	0.09362
		20			6.150	1.150	724	0.09475
		25			6.120	1.140	724	0.09362
		30			6.140	1.120	725	0.09616
		35			6.140	1.130	725	0.09558
		40			6.140	1.130	726	0.09585
		45			6.150	1.140	726	0.09585
		50			6.150	1.170	726	0.09413
	3	0	0.8762	1.0016	5.200	2.150	1011	0.03714
		5			5.110	2.250	1012	0.03068
		10			5.100	2.210	1010	0.03153
		15			5.050	2.150	1011	0.03193
		20			5.140	2.200	1011	0.03326
		25			5.040	2.110	1012	0.03299
		30			5.060	2.110	1012	0.03367
		35			5.140	2.160	1012	0.03471
		40			5.110	2.130	1010	0.03457
		45			5.310	2.320	1011	0.03499
		50			5.290	2.310	1011	0.03464
	5	0	0.8762	1.0276	6.000	1.450	1197	0.20862
		5			5.800	1.850	1196	0.13626

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1	5	10	0.8762	1.0276	5.560	2.390	1197	0.07055
		15			5.150	2.520	1196	0.04022
		20			4.660	3.040	1196	0.00940
		25			4.680	3.020	1196	0.01011
		30			4.630	2.930	1209	0.01110
		35			4.680	2.920	1209	0.01232
		40			4.700	2.980	1211	0.01153
		45			4.720	2.970	1212	0.01217
		50			4.710	2.980	1211	0.01174
	6	0	0.8762	1.0364	6.080	1.340	946	0.15584
		5			6.120	1.590	946	0.13603
		10			5.930	1.830	947	0.10107
		15			5.620	2.020	947	0.06842
		20			5.360	2.490	948	0.03474
		25			5.100	2.480	948	0.02643
		30			5.080	2.630	947	0.02157
		35			4.950	2.620	948	0.01859
		40			4.870	2.820	947	0.01263
		45			4.860	2.720	948	0.01440
		50			4.770	2.810	949	0.01109
	10	0	0.8762	1.0585	5.780	1.870	1014	0.11438
		5			5.780	1.900	1014	0.11177
		10			5.770	1.920	1013	0.10898
		15			5.780	1.940	1013	0.10813
		20			5.750	1.970	1014	0.10335
		25			5.750	1.980	1015	0.10273
		30			5.760	2.020	1015	0.10030
		35			5.740	2.020	1016	0.09889

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1	10	40	0.8762	1.0585	5.710	2.030	1017	0.09592
		45			5.710	2.090	1017	0.09131
		50			5.700	2.110	1018	0.08923

Table A7 Dynamic interfacial tension of each phase in microemulsion formation with 1.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1.5	2	0	0.8762	1.0100	5.700	1.810	560	0.02522
		5			5.700	1.790	561	0.02570
		10			5.685	1.800	561	0.02521
		15			5.690	1.805	562	0.02530
		20			5.695	1.810	560	0.02512
		25			5.690	1.805	561	0.02521
		30			5.690	1.800	563	0.02549
		35			5.685	1.810	562	0.02510
		40			5.680	1.800	561	0.02511
		45			5.690	1.795	561	0.02540
	4	0	0.8762	1.0287	5.720	2.030	423	0.01400
		5			5.730	2.120	424	0.01317
		10			5.710	2.220	418	0.01156
		15			5.660	2.230	418	0.01098
		20			5.590	2.030	418	0.01227
		25			5.610	2.010	418	0.01269
		30			5.690	2.090	418	0.01269
		35			5.540	2.010	420	0.01208
		40			5.610	2.010	418	0.01269
		45			5.510	1.980	418	0.01197
		50			5.510	1.970	417	0.01201
	5	0	0.8762	1.0332	5.840	1.710	1600	0.28906
		5			5.650	1.960	1600	0.20617
		10			5.360	2.370	1602	0.10996

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1.5	5	15	0.8762	1.0332	4.930	2.800	1604	0.03985
		20			4.740	3.060	1605	0.01958
		25			4.520	3.190	1608	0.00975
		30			4.440	3.190	1607	0.00808
		35			4.450	3.190	1607	0.00818
		40			4.460	3.190	1607	0.00848
		45			4.450	3.180	1607	0.00848
		50			4.460	3.200	1607	0.00828
	6	0	0.8762	1.0376	5.530	1.780	488	0.02069
		5			5.500	1.755	490	0.02078
		10			5.535	1.805	488	0.02036
		15			5.510	1.800	489	0.02012
		20			5.515	1.820	490	0.02004
		25			5.510	1.820	489	0.01980
		30			5.500	1.820	489	0.01972
		35			5.520	1.830	488	0.01980
		40			5.510	1.840	489	0.01948
		45			5.510	1.870	489	0.01908
		50			5.490	1.900	489	0.01823
		55			5.500	1.935	489	0.01785
		60			5.480	2.040	489	0.01604
		65			5.450	2.135	490	0.01441
		70			5.440	2.215	489	0.01322
		75			5.430	2.280	488	0.01227
		80			5.440	2.325	489	0.01191
		85			5.435	2.350	489	0.01157
		90			5.435	2.450	489	0.01048
	7	0	0.8762	1.0477	5.730	1.760	1204	0.15881

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Upper density (g/mL)	Lower density (g/mL)	Upper level	Lower level	Speed (rpm)	IFT (mN/m)
1.5	7	5	0.8762	1.0477	5.720	1.780	1206	0.15576
		10			5.690	1.800	1208	0.15040
		15			5.680	1.800	1207	0.14900
		20			5.660	1.820	1207	0.14444
		25			5.610	1.860	1207	0.13452
		30			5.580	1.910	1207	0.12609
		35			5.550	1.910	1208	0.12323
		40			5.520	2.000	1209	0.11162
		45			5.450	2.100	1208	0.09606
		50			5.390	2.160	1209	0.08624
		55			5.290	2.310	1208	0.06762
		60			5.260	2.370	1210	0.06188
		65			5.270	2.420	1209	0.05924
		70			5.200	2.460	1210	0.05273
		75			5.160	2.450	1210	0.05102
		80			5.210	2.480	1210	0.05216
	8	0	0.8762	1.0582	5.875	1.535	786	0.09384
		5			5.860	1.560	786	0.09127
	10	0	0.8762	1.0692	6.190	1.740	836	0.12135
		5			6.160	1.800	837	0.11441
		10			6.160	1.840	837	0.11129
		15			6.150	1.860	838	0.10925
		20			6.110	1.930	837	0.10082
		25			5.720	1.730	837	0.08769
		30			5.750	1.730	838	0.08989
		35			5.740	1.730	839	0.08944
		40			5.760	1.730	839	0.09078
		45			5.730	1.730	838	0.08856

3. Experimental Data of Electrolytic Conductivity

Table A8 Electrolytic conductivity of each phase in microemulsion formation with 0.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	2	30	3000.000	24.1
		32	2750.000	24.1
		34	2660.000	24.1
		36	2760.000	24.1
		38	2760.000	24.2
		40	2850.000	24.3
		42	2710.000	24.3
		44	2670.000	24.4
		46	2610.000	24.5
		48	2150.000	24.6
		50	475.000	24.7
		52	499.000	24.8
		54	506.000	24.8
		56	294.000	24.9
		58	326.000	24.9
		60	335.000	25.0
		62	330.000	25.0
		64	351.000	25.1
		66	295.000	25.1
		68	321.000	25.1
		70	336.000	25.1
		72	299.000	25.2
		74	323.000	25.2
		76	332.000	25.2

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	2	78	286.000	25.2
		80	285.000	25.2
		82	242.000	25.2
		84	247.000	25.2
		86	235.000	25.2
		88	236.000	25.2
		90	226.000	25.1
		92	174.300	25.1
		94	166.500	25.1
		96	167.500	25.1
		98	159.500	25.1
		100	139.000	25.1
		102	122.600	25.1
		104	119.700	25.1
		106	117.700	25.2
		108	108.100	25.3
		110	103.200	25.4
		112	95.100	25.4
		114	82.700	25.5
		116	78.000	25.5
		118	79.000	25.6
		120	73.300	25.7
		122	72.900	25.7
		125	67.400	25.8
		126	65.100	25.8
		128	63.800	25.9
		130	64.300	25.9
		132	63.300	26.0
		134	66.700	26.0

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	2	136	64.200	26.0
		138	60.900	26.1
		140	60.900	26.1
		142	69.500	26.1
		144	68.600	26.1
		146	69.300	26.2
		148	66.500	26.2
		150	60.900	26.3
		152	63.500	26.3
		154	52.600	26.3
		156	56.100	26.4
		158	61.500	26.4
		160	63.800	26.4
		ave	63.406	26.2
	3	30	3870.000	25.1
		32	2560.000	25.1
		34	1202.000	25.1
		36	1167.000	25.1
		38	1115.000	25.1
		40	974.000	25.1
		42	1003.000	25.2
		44	1054.000	25.2
		46	979.000	25.3
		48	1037.000	25.3
		50	974.000	25.3
		52	1040.000	25.4
		54	1170.000	25.5
		56	1217.000	25.6
		58	1336.000	25.8

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	3	60	1328.000	25.8
		62	1384.000	25.9
		64	1276.000	25.9
		66	1331.000	26.0
		68	1316.000	26.0
		70	1333.000	26.0
		72	1320.000	26.0
		ave	1299.864	25.9
	4	30	0.080	24.8
		35	57.400	25.0
		40	276.000	25.1
		45	282.000	25.3
		50	471.000	25.5
		55	793.000	25.6
		60	987.000	25.6
		62	1188.000	25.6
		64	1221.000	25.7
		66	1178.000	25.8
		68	1184.000	25.8
		70	1189.000	25.9
		71	1208.000	25.9
		72	1226.000	25.9
		73	1238.000	25.9
		74	1230.000	25.9
		75	1182.000	25.9
		ave	1196.538	25.7
	5	30	0.100	27.4
		32	0.200	27.5
		34	0.200	27.5

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	5	36	0.200	27.5
		38	0.200	27.6
		40	0.200	27.6
		42	0.200	27.6
		44	0.300	27.6
		46	0.200	27.6
		48	0.020	27.6
		50	0.400	27.6
		52	0.000	27.6
		54	0.230	27.6
		56	0.000	27.6
		58	0.000	27.6
		60	0.000	27.6
		65	0.000	27.5
		70	25.000	27.5
		72	43.500	27.5
		74	103.300	27.5
		76	195.000	27.5
		78	231.000	27.5
		80	317.000	27.5
		82	402.000	27.5
		84	489.000	27.5
		86	555.000	27.5
		88	610.000	27.5
		90	637.000	27.5
		92	687.000	27.5
		94	745.000	27.5
		96	765.000	27.5
		98	797.000	27.5

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	5	101	772.000	27.5
		102	770.000	27.5
		103	749.000	27.5
		104	725.000	27.5
		105	737.000	27.5
		106	708.000	27.5
		107	740.000	27.5
		108	737.000	27.5
		109	728.000	27.5
		110	712.000	27.5
		ave	748.563	27.5
	6	30	27.500	24.7
		35	38.600	24.7
		40	67.500	24.8
		45	112.600	24.9
		50	166.700	25.0
		55	190.700	25.2
		60	257.000	25.4
		65	269.000	25.4
		72	240.000	25.3
		75	234.000	25.1
		80	214.000	25.0
		85	202.000	24.9
		90	167.600	25.0
		91	163.900	25.0
		92	171.000	25.0
		93	170.100	25.0
		94	169.300	25.0
		95	172.700	25.0

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	6	96	176.800	25.1
		97	177.900	25.1
		98	174.900	25.1
		99	165.600	25.1
		ave	170.980	25.0
	7	30	0.000	26.6
		35	0.000	26.8
		40	0.000	26.8
		45	0.000	26.8
		50	0.000	26.9
		55	0.000	26.9
		60	0.000	27.0
		65	0.000	27.0
		70	0.000	27.1
		75	0.000	27.1
		80	0.000	27.2
		85	0.000	27.2
		90	0.000	27.2
		95	0.000	27.4
		ave	0.000	27.0
	10	30	0.000	24.6
		32	0.350	24.7
		34	0.430	24.7
		36	6.250	24.8
		38	0.730	24.8
		40	0.800	24.8
		42	0.820	24.9
		44	0.000	24.9
		46	0.520	25.0

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
0.5	10	48	0.540	25.0
		50	0.540	25.0
		52	0.760	25.1
		54	0.840	25.1
		56	0.000	25.1
		58	0.490	25.1
		60	0.790	25.2
		68	0.000	25.4
		70	0.000	25.4
		75	0.200	25.4
		80	0.100	25.5
		85	0.200	25.5
		ave	0.356	25.2

Table A9 Electrolytic conductivity of each phase in microemulsion formation with 1 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	2	30	699.000	23.5
		35	518.000	23.6
		40	488.000	23.9
		45	406.000	24.3
		50	398.000	24.7
		55	398.000	25.1
		60	398.000	25.4
		61	367.000	25.4
		62	363.000	25.5
		63	364.000	25.5
		64	370.000	25.5
		65	363.000	25.5
		66	360.000	25.5
		67	377.000	25.6
		ave	378.545	25.3
	3	30	1229.000	24.2
		35	724.000	24.2
		40	226.000	24.3
		45	105.900	24.4
		50	89.200	24.5
		55	114.200	24.6
		60	119.000	24.7
		65	131.400	24.8
		70	141.000	24.9
		75	144.600	24.9

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	3	80	162.100	25.0
		85	170.200	25.1
		90	173.500	25.1
		95	184.300	25.2
		100	183.200	25.3
		102	180.700	25.3
		104	172.800	25.3
		105	165.700	25.3
		106	165.700	25.3
		ave	173.133	25.2
	4	30	4610.000	25.0
		35	951.000	25.0
		40	375.000	25.0
		45	772.000	24.9
		50	1028.000	24.9
		55	1312.000	24.9
		60	1409.000	25.0
		65	1564.000	25.0
		70	1739.000	25.1
		75	1799.000	25.1
		80	1937.000	25.1
		85	4790.000	25.3
		90	4710.000	25.3
		95	4740.000	25.3
		100	4710.000	25.3
		105	4960.000	25.3
		106	5040.000	25.3
		108	5080.000	25.3
		110	4910.000	25.2

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	4	112	5010.000	25.2
		114	4800.000	25.2
		116	4970.000	25.1
		118	5020.000	25.1
		120	4960.000	25.1
		ave	4981.176	25.2
	5	30	924.000	26.6
		35	196.100	26.6
		40	187.200	26.5
		45	210.000	26.4
		50	199.800	26.3
		55	194.200	26.1
		60	196.200	25.9
		62	191.600	25.9
		64	194.600	25.8
		66	198.800	25.8
		68	212.000	25.7
		70	214.000	25.7
		72	198.000	25.6
		74	223.000	25.6
		ave	200.668	26.0
	6	30	0.000	23.6
		35	0.000	24.0
		40	0.000	24.3
		45	1.500	24.6
		50	3.500	25.0
		55	9.900	25.3
		60	14.500	25.4
		65	65.900	25.5

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	6	70	73.900	25.5
		75	126.300	25.4
		80	168.500	25.4
		85	208.000	25.3
		90	215.000	25.3
		92	223.000	25.3
		94	237.000	25.3
		96	245.000	25.4
		98	236.000	25.4
		100	220.000	25.4
		102	233.000	25.5
		104	247.000	25.5
		106	248.000	25.5
		108	248.000	25.5
		110	241.000	25.5
		112	232.000	25.5
		114	233.000	25.5
		ave	239.643	25.5
	7	30	0.000	27.2
		35	0.000	27.3
		40	0.010	27.2
		45	0.010	27.1
		50	0.000	26.9
		55	0.010	26.8
		60	0.000	26.6
		65	0.010	26.5
		70	0.000	26.4
		75	0.020	26.3
		80	0.000	26.1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	7	85	0.000	26.0
		ave	0.004	26.5
	8	30	0.000	26.3
		35	0.000	26.6
		40	0.000	26.7
		45	0.000	26.8
		50	0.000	26.8
		55	0.000	26.8
		60	0.000	26.8
		65	0.000	26.9
		70	0.000	26.9
		75	0.000	26.9
		80	0.000	27.0
		85	0.000	27.0
		90	0.000	27.1
		95	0.000	27.1
		ave	0.000	26.9
	10	30	0.000	25.5
		35	0.000	25.7
		40	0.000	25.9
		45	0.000	26.1
		50	0.000	26.2
		55	0.000	26.3
		60	0.000	26.4
		65	0.000	26.5
		70	0.000	26.5
		75	0.000	26.5
		80	0.000	26.6
		85	0.000	26.8

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1	10	90	0.000	26.9
		ave	0.000	26.4

Table A10 Electrolytic conductivity of each phase in microemulsion formation with 1.5 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1.5	3	30	2450.000	26.0
		35	577.000	25.9
		40	447.000	25.9
		45	326.000	25.8
		50	258.000	25.8
		55	289.000	25.8
		60	323.000	25.8
		65	340.000	25.8
		70	351.000	25.6
		75	292.000	25.6
		80	185.000	25.6
		85	269.000	25.6
		90	230.000	25.6
		95	207.000	25.6
		100	212.000	25.6
		105	232.000	25.6
		110	152.500	25.5
		115	254.000	25.5
		120	238.000	25.5
		125	207.000	25.5
		130	243.000	25.5
		ave	230.444	25.5
	4	30	769.000	26.5
		35	960.000	26.5
		40	1148.000	26.4

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1.5	4	45	1335.000	26.3
		50	1537.000	26.3
		55	1758.000	26.2
		60	1902.000	26.1
		65	1974.000	26.0
		70	5200.000	26.0
		75	5250.000	25.9
		80	5310.000	25.8
		85	5150.000	25.8
		90	5130.000	25.7
		92	5170.000	25.7
		94	5130.000	25.6
		96	5180.000	25.6
		98	5170.000	25.6
		100	5130.000	25.6
		ave	5160.000	25.7
	5	30	289.000	26.3
		35	296.000	26.4
		40	211.000	26.3
		45	268.000	26.2
		50	202.000	26.1
		55	205.000	26.0
		ave	203.500	26.2
	7	30	0.000	24.9
		35	0.000	25.0
		40	0.000	25.0
		45	0.410	25.0
		50	18.560	25.0
		55	24.400	25.0

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1.5	7	60	23.600	25.0
		62	23.000	25.0
		65	24.300	25.0
		66	21.700	25.0
		67	22.700	25.0
		68	22.500	25.0
		69	25.700	25.0
		70	21.500	25.0
		71	20.400	25.0
		72	20.700	25.0
		73	25.400	25.0
		74	22.300	25.0
		75	22.500	25.0
		ave	23.006	25.0
	8	30	0.000	26.5
		35	0.000	26.7
		40	0.000	26.8
		45	0.000	26.8
		50	0.000	26.9
		55	0.000	26.9
		60	0.000	27.0
		65	0.000	26.9
		ave	0.000	26.8
	10	30	0.000	25.4
		35	0.000	25.6
		40	0.000	25.7
		45	0.000	26.0
		50	0.000	26.0
		55	0.000	26.3

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
1.5	10	60	0.000	26.6
		ave	0.000	26.3

Table A11 Electrolytic conductivity of each phase in microemulsion formation with 3 wt.% of Alfoterra at different NaCl concentrations and an initial oil to water ratio = 1:1

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
3	3	45	272.000	26.4
		50	242.000	26.5
		55	181.900	26.6
		60	131.500	26.7
		65	51.200	26.6
		70	37.500	26.4
		75	55.900	26.0
		80	58.900	25.7
		85	77.600	25.5
		90	100.600	25.3
		95	97.200	25.2
		100	99.900	25.1
		102	105.900	25.1
		104	108.400	25.1
		106	104.300	25.0
		108	104.000	25.0
		110	101.100	25.0
		112	104.600	25.0
		114	100.900	24.9
		ave	103.947	25.0
	4	45	5300.000	24.9
		50	3260.000	25.1
		55	292.000	25.3
		60	5.570	25.3
		65	1.300	25.4

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
3	4	70	0.450	25.5
		75	128.100	25.6
		80	265.000	25.6
		85	236.000	25.6
		90	243.000	25.6
		92	260.000	25.5
		94	270.000	25.5
		96	291.000	25.4
		97	296.000	25.4
		98	296.000	25.4
		99	299.000	25.4
		100	296.000	25.4
		101	299.000	25.4
		102	305.000	25.4
		103	308.000	25.3
		104	300.000	25.3
		105	292.000	25.3
		ave	299.875	25.4
	5	45	1687.000	25.6
		50	8070.000	25.6
		55	7430.000	25.6
		60	6780.000	25.5
		65	4650.000	25.4
		70	4830.000	25.3
		75	5040.000	25.2
		80	5170.000	25.1
		85	5270.000	25.0
		90	5330.000	24.9
		95	5350.000	24.8

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
3	5	96	5370.000	24.8
		97	5350.000	24.8
		98	5350.000	24.8
		99	5340.000	24.8
		100	5390.000	24.8
		101	5380.000	24.8
		102	5390.000	24.8
		103	5400.000	24.9
		104	5370.000	24.9
		105	5360.000	24.9
		ave	5368.182	24.8
	6	45	501.000	23.8
		50	83.000	23.8
		55	14.000	23.8
		60	58.000	23.9
		65	418.000	24.0
		70	755.000	24.0
		75	849.000	24.0
		80	860.000	24.0
		81	860.000	24.0
		82	861.000	24.0
		83	861.000	24.0
		84	864.000	24.0
		85	866.000	24.0
		ave	862.000	24.0
	9	45	3.000	24.3
		50	3.000	24.4
		55	3.000	24.5
		60	3.000	24.5

Alfoterra Conc. (wt.%)	NaCl Conc. (wt.%)	Time (min)	Electrolytic conductivity (μS)	Temperature (°C)
3	9	65	2.000	24.5
		70	2.000	24.5
		75	2.000	24.5
		80	2.000	24.5
		85	2.000	24.5
		90	2.000	24.5
		ave	2.000	24.5
	10	45	0.200	25.2
		50	0.200	25.2
		55	0.200	25.2
		60	0.200	25.2
		65	0.200	25.2
		70	0.200	25.2
		75	0.200	25.1
		80	0.200	25.1
		ave	0.200	25.2

Appendix B Experimental data of froth flotation experiment.

1. Oil Removal

The oil removal was calculated by the following formulation:

$$\text{Oil removal (\%)} = \frac{C_t F_t - C_i F_i}{C_t F_t} \times 100 \qquad \text{(B1)}$$

where C_t = concentration of oil in an effluent (wt.%)

C_i = concentration of oil in an influent (wt.%)

F_t = volumetric flow rate of an effluent (mL/min)

F_i = volumetric flow rate of an influent (mL/min)

2. Surfactant Removal

The surfactant removal was interpreted by the following equations:

$$\text{Surfactant removal (\%)} = \frac{C_{s,t} F_{s,t} - C_{s,i} F_{s,i}}{C_{s,t} F_{s,t}} \times 100 \qquad \text{(B2)}$$

where $C_{s,t}$ = concentration of surfactant in an effluent (wt.%)

$C_{s,i}$ = concentration of surfactant in an influent (wt.%)

F_t = volumetric flow rate of an effluent (mL/min)

F_i = volumetric flow rate of an influent (mL/min)

3. Enrichment Ratio

The enrichment was calculated by the following equations:

$$\text{Enrichment ratio} = \frac{C_f}{C_i} \qquad \text{(B3)}$$

where C_f = concentration of oil in the collapsed foam solution

C_i = concentration of oil in an influent

4. Effective Parameter on Froth Flotation

Table B1 Summary results of froth flotation performance of all system in the surfactant concentration effect at NaCl concentration = 5 wt.%, oil:water ratio = 1:1, air flow rate = 0.30 L/min, HRT = 30 min, foam height = 26 cm

System	Alfoterra concentration (wt.%)	Oil removal (%)	Enrichment ratio of oil	Surfactant removal	Enrichment ratio of surfactant	Foam wetness (g/mL)	Foam production rate (mL/min)
1:1 Alf0.3 N5	0.3	45.29	0.76	19.04	0.37	1.0352	13.54
1:1 Alf0.5 N5	0.5	61.49	0.86	48.76	1.03	1.0367	23.69
1:1 Alf1.0 N5	1.0	46.97	0.80	24.11	0.87	1.0359	14.40
1:1 Alf1.5 N5	1.5	56.79	0.56	31.79	0.78	1.0307	23.88

Table B2 Summary results of froth flotation performance of all system in the HRT effect at Alfoterra concentration = 0.5 wt.%, NaCl concentration = 5 wt.%, oil:water ratio = 1:1, air flow rate = 0.30 L/min, foam height = 26 cm

System	HRT (min)	Oil removal (%)	Enrichment ratio of oil	Surfactant removal	Enrichment ratio of surfactant	Foam wetness (g/mL)	Foam production rate (mL/min)
1:1 Alf0.5 N5 (f = 66 mL/min)	30	61.49	0.86	48.76	1.03	1.0367	23.69
1:1 Alf0.5 N5 (f = 44 mL/min)	45	55.16	0.71	49.53	0.87	1.0301	14.08
1:1 Alf0.5 N5 (f = 33 mL/min)	60	40.95	1.05	39.31	0.91	1.0397	11.76

Appendix C Experimental data of foamability and foam stability experiment.

1. Foamability

The foamability was defined as the ratio of maximum foam height to initial solution height

$$\text{Foamability} = \frac{H_{max.}}{H_i} \qquad \text{(C1)}$$

where $H_{max.}$ = Maximum foam height

H_i = Initial solution height

2. Foam Stability ($t_{1/2}$)

The foam stability was defined as the time that was required for the foam volume to collapse by half.

3. Effective parameter on foamability and foam stability

Table C1 Summary results of foamability and foam stability for the non-agitated surfactant system at NaCl concentration = 5 wt.%, oil:water ratio = 1:1, air flow rate = 0.1 L/min

System	Alfoterra concentration(wt.%)	Foam ability	Foam stability(min)
1:1 Alf0.5 N5	0.5	3.70	12.98
1:1 Alf1.0 N5	1.0	3.16	11.95
1:1 Alf1.5 N5	1.5	3.96	13.70

Appendix D Experimental data of bubble size distribution.

Table D1 Average bubble diameter between the surfactant-free system and the surfactant systems at different positions

Positions	Pure water	Alfoterra concentration (wt.%)			
		0.3	0.5	1	1.5
Top	464.83	171.12	173.76	168.15	169.14
Middle	374.63	159.67	151.19	162.49	185.57
Bottom	463.96	134.24	156.97	157.47	178.95

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