REFERENCES

Aveyard, R., Blinks, B.P., Fletcherand, P.D.I., and Rutherford, C.E. (1994). Contact angle in relation to the effects of solids on film and foam stability. Journal of Dispersion Science and Technology, 15(3), 251-271.

Averyard, R., Cooper, P., Fletcherand, P.D.I., and Rutherford, C. E. (1993). Foam breakdown by hydrophobic particle and nonpolar oil. Langmiur, 9, 604-613.

Dippennar, A. (1982a). The destabilization of froth by solids: 1 The mechanism of film rupture. International Journal of Mineral Processing, 9(1), 1-14.

Dippennar, A. (1982b). The destabilization of froth by solids: 2 The rate determining step. International Journal of Mineral Processing, 9(1), 15-22.

Frye, D.C., Berg, J.C. (1989). Antifoam action by solid particles. Journal of Colloid and Interface Science, 127(1), 222-238.

Garrett, P.R. (1979). Effect of polytetrafluoroethylene particles on the foamability of aqueous surfactant solutions. Journal of Colloid and Interface Science, 69(1), 107-121.

Garrett, P.R. (1992). Defoaming: Theory and industrial applications. New York: Marcel Dekker.

Garrett, P.R., Davis, J., Rendall, H.M. (1993). An experimental study of the antifoam behaviour of mixtures of a hydrocarbon oil and hydrophobic particles. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 85, 159-197.

Goon, P., Bhirud, R.G., and Kumar, V.V. (1999). Detergency and foam studies on linear alkylbenzene sulfonate and secondary alkyl sulfonate. Journal of Surfactants and Detergents, 2(4), 489-493.

Iglesias, E., Anderez, J., Forgiarinr, A., Salager, J.L. (1995). A new method to estimate the stability of short-life foams. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 98, 167-174.

Jha, B.K., Patist, A., and Shah, D.O. (1999). Effect of antifoaming agents on the micellar stability and foamability of sodium dodecyl sulfate solutions. Langmiur, 15, 3042-3044.

Johansson, G., and Pugh, R.J. (1992). Influence of particle size and hydrophobicity on the stability of mineralized froths. International Journal of Mineral Processing, 34, 1.

Koczo, K., Koczone, J.K., and Wasan, D.T. (1994). Mechanisms for antifoaming action in aqueous system by hydrophobic particles and insoluble liquids. Journal of Colloid and Interface Science, 166, 255-238.

Kulkarni, R.D., Goddard, E.D., and Kanner, B. (1997). Mechanism of antifoaming: Role of filler particle. Industrial Engineering Chemical Fundamental, 16(4), 472-474.

Laheja, A.P., Basak, S., Patil, R.M., and Khilar, K.C. (1997). Experimental observations on drainage of foams generated using micellar solutions of anionic, cationic, and nonionic surfactants. Langmiur, 14, 560-564.

Nemeth, Z., Racz, G., and Koczo, K. (1998). Foam control by silicone polyethers-mechanisms of "cloud point antifoaming". Journal of Colloid and Interface Science, 207, 386-394.

Patist, A., Huibers, P.D.T., Deneka, B., and Shah, D.O. (1998). Effect of tetraalkylammonium chlorides on foaming properties of sodium dodecyl sulfate Solutions. Langmiur, 14, 4471-4474.

Pepper, H. (1958). The defoaming of synthetic detergent solutions by soaps and fatty acids. Journal of Colloid Science, 13, 199-207.

Porter, M.R. (1994) Handbook of Surfactants. 2nd ed. Glasgow: Blackie Academic & Professional.

Prud'homme, R.B. (1996). Foam: Theory, Measurements, and Applications. Marcel Dekker, New York.

Pugh, R.J., (1996). Foaming, foam films, antifoaming and defoaming. Advances in colloid and interface science, 64, 67-142.

Rodriguez, C.H. (1997) The thermodynamics and kinetics of precipitation of anionic surfactants and surfactant mixtures. Doctor of philosophy Dissertation in Graduate College, University of Oklahoma.

Rodriguez, C.H., Chintanasathien, C., Scamehorn, J.F., Saiwan, C., and Chvadej, S. (1998). Precipitation in solutions containing mixtures of synthetic anionic surfactant and soap. I. effect of sodium octanoate on hardness tolerance of sodium dodecyl sulfate. Journal of Surfactants and Detergents, 1(3), 321-328.

Rosen, M.J., (1989). Surfactants and Interfacial Phenomena. 2nd ed. New York: Wiley, 1988.

Srikajorn, P. (2000). Foaming of anionic surfactant in the presence of calcium soap precipitate. M.S. Thesis in Petroleum Technology, The Petroleum and Petrochemical College, Chulalongkorn University.

Tamura, T., Kageyama, M., Kaneko, Y., Kishino, T., and Nikaido, M. (1999). Direct observation of foam film rupture by several types of antifoams using a scanning laser microscope. Journal of Colloid and Interface Science, 213, 179-186.

Wang, G., Pelton, R., Hrymak, A., Shawafaty, N., and Heng, Y.M. (1998). On the role of hydrophobic particles and surfactants in defoaming. Langmiur, 15, 2202-2208.

APPENDICES

Appendix A : Contact angle measurement

Table A-1 The contact angle of SDS solution of varying concentration on calcium soap surface.

Concentration of SDS (mM)	CaC12	CaC14	CaC18	CaC22
0	68.85	77.65	87.25	100.45
2	57.35	65.25	73.8	81.05
4	52	55.95	63.6	74.9
6	48.1	53.75	59.8	70.5
8	47.8	53.35	59.55	68.75
10	47.15	52.25	59.5	67.95
20	47.55	53.15	59.45	68

Appendix B : Foaming properties of SDS solution in the presence of calcium soap

Concentration of SDS = 10 mM

Concentration of calcium soap = 0.5 mM

Temperature = 30°C

pH = 7

Table B-1 The change in foam height with time using the Ross-Miles foam test.

Time (min.)	Pure SDS	CaC12	CaC14	CaC18	CaC22
0	21.8	23.5	23.7	22.5	21.7
5	19.6	20.8	21.2	20.4	18.8
10	19.2	20.7	21.2	20.3	18.3
15	19.0	20.7	21.1	20.2	17.9
20	18.8	20.5	20.9	19.9	17.5
25	18.6	20.5	20.9	19.6	16.8
30	18.5	20.5	20.9	19.6	14.0
35	18.4	20.4	20.9	19.4	12.0
40	18.3	20.4	20.9	19.2	10.0
45	18.3	20.4	20.8	19.1	8.3
50	18.2	20.4	20.8	19.0	7.5
55	18.1	20.4	20.8	19.0	6.8
60	17.9	20.4	20.8	19.0	6.5
65	17.9	20.4	20.8	18.9	6.2
70	17.8	20.4	20.7	18.9	6.0
75	17.8	20.4	20.7	18.8	5.8
80	17.7	20.4	20.7	18.6	5.8
85	17.6	20.4	20.7	18.4	5.7
90	17.5	20.4	20.7	18.3	5.6
95	17.3	20.4	20.7	18.2	5.5
100	17.2	20.4	20.7	18.0	5.4
105	17.2	20.4	20.7	18.0	5.3

Time (min.)	Pure SDS	CaC12	CaC14	CaC18	CaC22
110	17.1	20.4	20.7	17.9	5.3
115	17.0	20.3	20.6	17.9	5.2
120	16.9	20.3	20.6	17.5	5.0
125	16.9	20.3	20.6	16.7	4.9
130	16.8	20.3	20.6	16.2	4.8
135	16.7	20.3	20.6	15.8	4.6
140	16.6	20.3	20.6	15.4	4.5
145	16.6	20.3	20.6	15.1	4.4
150	16.5	20.3	20.5	14.6	4.2
155	16.4	20.3	20.5	14.2	4.2
160	16.3	20.3	20.5	13.9	4.1
165	16.2	20.3	20.5	13.6	4.0
170	16.1	20.3	20.5	13.3	3.9
175	16.1	20.3	20.5	13.0	3.9
180	16.1	20.2	20.5	12.7	3.9
185	15.9	20.2	20.5	12.5	3.8
190	15.9	20.2	20.5	12.2	3.8
195	15.8	20.2	20.5	11.9	3.7
200	15.6	20.2	20.5	11.6	3.6
205	15.5	20.2	20.4	11.4	3.6
210	15.5	20.2	20.4	11.3	3.6
215	15.3	20.2	20.4	11.3	3.5
220	15.2	20.2	20.4	11.2	3.5
225	15.1	20.2	20.4	11.0	3.4
230	15.1	20.2	20.4	11.0	3.3
235	15.0	20.2	20.4	10.8	3.3
240	15.0	20.2	20.4	10.7	3.3
245	15.0	20.2	20.4	10.7	3.2
250	14.9	20.2	20.4	10.5	3.2
255	14.8	20.2	20.4	10.4	3.1
260	14.8	20.2	20.4	10.4	3.0
265	14.7	20.2	20.4	10.4	2.9
270	14.6	20.2	20.4	10.2	2.9
275	14.6	20.2	20.4	10.1	2.9
280	14.6	20.2	20.4	10.0	2.9
285	14.5	20.2	20.4	9.9	2.8
290	14.4	20.2	20.4	9.9	2.8

Time (min.)	Pure SDS	CaC12	CaC14	CaC18	CaC22
295	14.4	20.2	20.4	9.8	2.8
300	14.3	20.2	20.4	9.7	2.7
305	14.2	20.2	20.4	9.7	2.7
310	14.2	20.2	20.4	9.6	2.7
315	14.1	20.2	20.3	9.5	2.6
320	14.0	20.2	20.3	9.5	2.6
325	14.0	20.2	20.3	9.5	2.5
330	13.8	20.2	20.3	9.5	2.5
335	13.8	20.2	20.3	9.4	2.5
340	13.6	20.2	20.3	9.4	2.4
345	13.5	20.1	20.3	9.4	2.4
350	13.2	20.1	20.3	9.3	2.4
355	13.0	20.1	20.3	9.3	2.4
360	13.0	20.1	20.3	9.3	2.4

Appendix C : The effect of particle size of calcium soap on the foaming properties of SDS solution

Concentration of SDS = 10 mM

Concentration of calcium soap = 0.5 mM

Temperature = 30°C

pH = 7

Table C-1 The change in foam height with time of sodium dodecyl sulfate solution in the presence of calcium soap which has the particle size in the range of < 212 μm.

Time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
0	21.8	23.0	23.5	22.6	23.0
5	19.6	20.4	21.1	20.2	20.2
10	19.2	20.3	20.9	20.0	19.9
15	19.0	20.2	20.8	20.0	19.3
20	18.8	20.2	20.6	20.0	18.3
25	18.6	20.2	20.5	20.0	17.3
30	18.5	20.1	20.5	19.9	15.5
35	18.4	20.1	20.5	19.9	13.5
40	18.3	20.1	20.4	19.8	11.7
45	18.3	20.1	20.4	19.8	10.3
50	18.2	20.1	20.3	19.8	9.0
55	18.1	20.1	20.3	19.8	8.0
60	17.9	20.0	20.3	19.8	7.2
65	17.9	20.0	20.3	19.7	6.5
70	17.8	20.0	20.3	19.7	5.8
75	17.8	20.0	20.2	19.7	5.4
80	17.7	20.0	20.2	19.7	5.0
85	17.6	20.0	20.2	19.7	4.8
90	17.5	19.9	20.2	19.6	4.6
95	17.3	19.9	20.1	19.6	4.5
100	17.2	19.9	20.1	19.6	4.4
105	17.2	19.9	20.1	19.6	4.3
110	17.1	19.9	20.1	19.5	4.3

Time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
115	17.0	19.9	20.0	19.5	4.2
120	16.9	19.9	20.0	19.2	4.1
125	16.9	19.9	20.0	19.0	4.0
130	16.8	19.9	19.9	18.4	3.9
135	16.7	19.9	19.9	18.0	3.8
140	16.6	19.9	19.9	17.7	3.7
145	16.6	19.9	19.9	17.3	3.6
150	16.5	19.9	19.9	16.9	3.6
155	16.4	19.9	19.8	16.5	3.5
160	16.3	19.9	19.8	16.2	3.5
165	16.2	19.9	19.8	15.9	3.4
170	16.1	19.9	19.8	15.7	3.3
175	16.1	19.8	19.8	15.4	3.2
180	16.1	19.8	19.8	15.1	3.1
185	15.9	19.8	19.8	14.9	3.1
190	15.9	19.8	19.8	14.7	3.0
195	15.8	19.8	19.8	14.5	2.9
200	15.6	19.8	19.8	14.2	2.9
205	15.5	19.8	19.7	13.9	2.9
210	15.5	19.8	19.7	13.7	2.8
215	15.3	19.7	19.7	13.6	2.7
220	15.2	19.7	19.7	13.4	2.7
225	15.1	19.7	19.7	13.3	2.7
230	15.1	19.7	19.7	13.2	2.6
235	15.0	19.7	19.7	13.1	2.6
240	15.0	19.6	19.7	13.1	2.6
245	15.0	19.6	19.7	13.0	2.6
250	14.9	19.6	19.7	12.8	2.5
255	14.8	19.6	19.7	12.7	2.5
260	14.8	19.6	19.7	12.7	2.5
265	14.7	19.6	19.6	12.6	2.4
270	14.6	19.6	19.6	12.5	2.4
275	14.6	19.6	19.6	12.4	2.4
280	14.6	19.6	19.6	12.3	2.4
285	14.5	19.6	19.6	12.2	2.4
290	14.4	19.6	19.6	12.2	2.3
295	14.4	19.6	19.6	12.1	2.3
300	14.3	19.6	19.6	12.0	2.3
305	14.2	19.6	19.6	11.9	2.2
310	14.2	19.6	19.6	11.8	2.2
315	14.1	19.6	19.6	11.7	2.1
320	14.0	19.6	19.5	11.5	2.1

Time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
325	14.0	19.6	19.5	11.4	2.1
330	13.8	19.6	19.5	11.3	2.0
335	13.8	19.6	19.5	11.2	2.0
340	13.6	19.6	19.5	11.1	1.9
345	13.5	19.6	19.5	11.0	1.9
350	13.2	19.5	19.5	11.0	1.9
355	13.0	19.5	19.5	10.9	1.9
360	13.0	19.5	19.5	10.9	1.9

Table C-2 The change in foam height with time of sodium dodecyl sulfate solution in the presence of calcium soap which has the particle size in the range of 212-425 μm.

Time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
0	21.8	23.5	23.7	23.0	23.6
5	19.6	21.1	21.4	20.4	20.5
10	19.2	20.9	21.4	20.4	20.0
15	19.0	20.8	21.4	20.2	19.5
20	18.8	20.7	21.2	20.1	18.8
25	18.6	20.7	21.2	20.0	18.2
30	18.5	20.6	21.2	20.0	16.9
35	18.4	20.6	21.2	20.0	15.4
40	18.3	20.5	21.1	20.0	13.5
45	18.3	20.5	21.1	19.9	12.4
50	18.2	20.5	21.1	19.9	11.7
55	18.1	20.5	21.1	19.8	10.4
60	17.9	20.5	21.0	19.7	9.9
65	17.9	20.4	21.0	19.7	9.2
70	17.8	20.4	21.0	19.6	8.6
75	17.8	20.4	20.9	19.5	8.4
80	17.7	20.4	20.9	19.5	8.2
85	17.6	20.3	20.9	19.4	7.8
90	17.5	20.3	20.9	19.4	7.3
95	17.3	20.3	20.9	19.3	7.1
100	17.2	20.3	20.9	19.2	7.0
105	17.2	20.3	20.8	19.2	6.8

time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
110	17.1	20.2	20.8	19.2	6.6
115	17.0	20.2	20.8	19.2	6.3
120	16.9	20.2	20.8	19.1	6.2
125	16.9	20.2	20.8	18.8	6.1
130	16.8	20.2	20.8	18.2	6.1
135	16.7	20.1	20.8	17.7	6.1
140	16.6	20.1	20.8	17.4	5.9
145	16.6	20.1	20.8	17.0	5.8
150	16.5	20.1	20.8	16.6	5.7
155	16.4	20.1	20.8	16.2	5.7
160	16.3	20.0	20.8	15.9	5.6
165	16.2	20.0	20.7	15.6	5.4
170	16.1	20.0	20.7	15.4	5.1
175	16.1	20.0	20.7	15.1	5.1
180	16.1	20.0	20.7	14.8	5.0
185	15.9	20.0	20.7	14.5	5.0
190	15.9	20.0	20.6	14.4	5.0
195	15.8	20.0	20.6	14.2	4.9
200	15.6	20.0	20.6	13.9	4.9
205	15.5	20.0	20.6	13.6	4.8
210	15.5	19.9	20.6	13.4	4.7
215	15.3	19.9	20.6	13.3	4.7
220	15.2	19.9	20.5	13.1	4.6
225	15.1	19.9	20.5	13.0	4.5
230	15.1	19.9	20.5	12.9	4.4
235	15.0	19.9	20.5	12.8	4.4
240	15.0	19.8	20.5	12.8	4.3
245	15.0	19.8	20.4	12.7	4.3
250	14.9	19.8	20.4	12.5	4.2
255	14.8	19.7	20.4	12.4	4.1
260	14.8	19.7	20.3	12.4	4.1
265	14.7	19.6	20.3	12.4	4.1
270	14.6	19.6	20.3	12.2	4.0
275	14.6	19.6	20.3	12.1	3.9
280	14.6	19.6	20.3	12.0	3.8
285	14.5	19.6	20.3	11.9	3.7
290	14.4	19.6	20.3	11.8	3.6
295	14.4	19.6	20.3	11.8	3.6
300	14.3	19.5	20.3	11.7	3.4
305	14.2	19.5	20.3	11.5	3.3
310	14.2	19.5	20.3	11.5	3.3

Time (min)	Pure SDS	CaC12	CaC14	CaC18	CaC22
315	14.1	19.5	20.2	11.4	3.3
320	14.0	19.5	20.2	11.2	3.2
325	14.0	19.5	20.2	11.1	3.2
330	13.8	19.5	20.2	11.0	3.2
335	13.8	19.5	20.2	10.9	3.1
340	13.6	19.4	20.1	10.8	3.1
345	13.5	19.4	20.1	10.7	3.1
350	13.2	19.4	20.1	10.7	3.1
355	13.0	19.4	20.1	10.7	3.1
360	13.0	19.4	20.1	10.6	3.1

Appendix D : The effect of concentration of calcium soap on the foaming properties of SDS

Concentration of SDS = 10 mM

Temperature = 30°C

Table D-1 The change in foam height with time of SDS solution in the presence of varying concentration of CaC_{14} and CaC_{22}.

Time (min)	CaC_{14} 0.5 mM	CaC_{14} 2 mM	CaC_{22} 0.5 mM	CaC_{22} 2 mM
	pH = 5.28	pH = 5.77	pH = 5.15	pH = 5.40
0	23.4	24.3	22.5	23.7
1	21.3	22.3	20.9	21.9
2	21.0	22.1	20.6	21.7
3	20.9	21.8	20.3	21.6
4	20.8	21.8	20.1	21.4
5	20.8	21.7	20.0	21.1
10	20.7	21.7	18.2	19.6
15	20.7	21.5	14.7	16.8
20	20.7	21.5	12.2	13.9
25	20.6	21.5	9.2	10.9
30	20.6	21.5	7.7	8.4
35	20.6	21.5	6.2	7.2
40	20.6	21.4	5.4	6.2
45	20.5	21.3	5.0	5.9
50	20.5	21.3	4.5	5.6
55	20.5	21.3	4.0	5.1
60	20.5	21.3	3.4	4.6
65	20.5	21.2	3.1	4.1
70	20.5	21.2	2.9	3.8
75	20.5	21.2	2.8	3.5
80	20.5	21.2	2.8	3.3
85	20.5	21.2	2.8	3.1
90	20.5	21.2	2.8	2.9
95	20.5	21.2	2.8	2.7
100	20.5	21.2	2.8	2.5

Time (min)	CaC_{14} 0.5 mM	CaC_{14} 2 mM	CaC_{22} 0.5 mM	CaC_{22} 2 mM
	pH = 5.28	pH = 5.77	pH = 5.15	pH = 5.40
105	20.4	21.1	2.8	2.4
110	20.4	21.1	2.8	2.4
115	20.4	21.1	2.8	2.4
120	20.4	21.1	2.7	2.4
125	20.4	21.1	2.7	2.4
130	20.4	21.1	2.7	2.4
135	20.4	21.1	2.6	2.4
140	20.4	21.1	2.6	2.4
145	20.4	21.1	2.6	2.4
150	20.4	21.1	2.6	2.3
155	20.4	21.1	2.6	2.3
160	20.4	21.0	2.6	2.3
165	20.3	21.0	2.5	2.3
170	20.3	21.0	2.5	2.3
175	20.3	21.0	2.5	2.3
180	20.3	21.0	2.5	2.3
185	20.3	20.9	2.5	2.3
190	20.3	20.9	2.5	2.3
195	20.3	20.9	2.5	2.2
200	20.3	20.9	2.5	2.2
205	20.3	20.9	2.4	2.2
210	20.3	20.8	2.4	2.2
215	20.3	20.8	2.4	2.2
220	20.3	20.8	2.4	2.2
225	20.3	20.8	2.4	2.2
230	20.2	20.8	2.4	2.2
235	20.2	20.8	2.4	2.2
240	20.2	20.8	2.4	2.2
245	20.2	20.7	2.3	2.2
250	20.2	20.7	2.3	2.2
255	20.2	20.7	2.3	2.1
260	20.2	20.7	2.3	2.1
265	20.2	20.7	2.3	2.1
270	20.1	20.7	2.2	2.1
275	20.1	20.7	2.2	2.1
280	20.1	20.7	2.2	2.1
285	20.1	20.7	2.2	2.1
290	20.1	20.7	2.2	2.1
295	20.1	20.7	2.2	2.1

Time (min)	CaC_{14} 0.5 mM	CaC_{14} 2 mM	CaC_{22} 0.5 mM	CaC_{22} 2 mM
	pH = 5.28	pH = 5.77	pH = 5.15	pH = 5.40
300	20.1	20.7	2.2	2.1
305	20.1	20.6	2.2	2.1
310	20.1	20.6	2.2	2.1
315	20.1	20.6	2.2	2.1
320	20.1	20.6	2.2	2.1
325	20.1	20.6	2.2	2.1
330	20.1	20.6	2.2	2.1
335	20.0	20.5	2.1	2.1
340	20.0	20.5	2.1	2.1
345	20.0	20.5	2.1	2.1
350	20.0	20.5	2.1	2.1
355	20.0	20.5	2.1	2.1
360	20.0	20.5	2.1	2.1

Appendix E : The effect hardness tolerance on the foaming properties of SDS in the presence of calcium soaps

Concentration of SDS = 10 mM

Concentration of calcium soap = 0.5 mM

Temperature = 30°C

Table E-1 The effect of hardness tolerance on the foaming properties of pure SDS solution.

Time (min)	Pure SDS	SDS+$CaCl_2$ 2 mM	SDS+$CaCl_2$ 5 mM
	pH = 5.88	pH = 5.85	pH = 5.99
0	22.5	23.1	16.5
1	20.0	22.0	14.9
2	19.8	21.6	14.4
3	19.5	21.3	13.9
4	19.4	21.2	13.5
5	19.2	20.9	11.4
10	18.9	19.8	5.4
15	18.7	12.1	3.5
20	18.5	6.8	3.5
25	18.3	5.0	3.0
30	18.1	4.5	2.8
35	17.9	4.3	2.8
40	17.7	4.0	2.7
45	17.5	3.7	2.6
50	17.4	3.7	2.5
55	17.2	3.6	2.5
60	17.1	3.5	2.5
65	16.9	3.3	2.4
70	16.8	3.1	2.4
75	16.7	3.0	2.3
80	16.5	2.9	2.3
85	16.4	2.7	2.3
90	16.1	2.7	2.2
95	16.0	2.7	2.2

Time (min)	Pure SDS	SDS+$CaCl_2$ 2 mM	SDS+$CaCl_2$ 5 mM
	pH = 5.88	pH = 5.85	pH = 5.99
100	15.9	2.6	2.2
105	15.8	2.6	2.2
110	15.7	2.6	2.2
115	15.5	2.5	2.2
120	15.3	2.5	2.2
125	15.2	2.4	2.1
130	15.0	2.3	2.1
135	14.8	2.3	2.1
140	14.6	2.2	2.1
145	14.5	2.1	2.1
150	14.3	2.1	2.1
155	14.2	2.1	2.1
160	14.0	2.1	2.1
165	13.8	2.1	2.1
170	13.6	2.1	2.1
175	13.4	2.1	2.0
180	13.3	2.1	2.0
185	13.0	2.1	2.0
190	12.9	2.0	2.0
195	12.7	2.0	2.0
200	12.5	2.0	2.0
205	12.4	2.0	2.0
210	12.3	2.0	2.0
215	12.1	2.0	2.0
220	11.8	2.0	2.0
225	11.6	2.0	2.0
230	11.5	2.0	2.0
235	11.3	2.0	1.9
240	11.1	2.0	1.9
245	11.0	1.9	1.9
250	10.8	1.9	1.9
255	10.7	1.9	1.9
260	10.5	1.9	1.9
265	10.3	1.9	1.9
270	10.1	1.9	1.9
275	10.0	1.9	1.9
280	9.9	1.9	1.9
285	9.8	1.9	1.8
290	9.7	1.9	1.8

Time (min)	Pure SDS	SDS+$CaCl_2$ 2 mM	SDS+$CaCl_2$ 5 mM
	pH = 5.88	pH = 5.85	pH = 5.99
295	9.6	1.9	1.8
300	9.5	1.9	1.8
305	9.4	1.9	1.8
310	9.2	1.9	1.8
315	9.0	1.8	1.8
320	8.9	1.8	1.8
325	8.8	1.8	1.7
330	8.7	1.8	1.7
335	8.5	1.8	1.7
340	8.4	1.8	1.7
345	8.3	1.8	1.7
350	8.2	1.8	1.7
355	8.1	1.8	1.7
360	8.0	1.8	1.7

Table E-2 The effect of hardness tolerance on the foaming properties of SDS solution in the presence of CaC_{14}.

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$CaCl_2$ 2 mM	CaC_{14}+$CaCl_2$ 5 mM
	pH = 5.28	pH = 5.40	pH = 4.73
0	23.4	23.3	10.5
1	21.3	20.8	9.3
2	21.0	20.3	7.4
3	20.9	20.2	6.8
4	20.8	20.2	6.8
5	20.8	20.2	6.7
10	20.7	20.1	6.6
15	20.7	20.1	6.4
20	20.7	20.0	6.3
25	20.6	20.0	6.2
30	20.6	19.9	6.2
35	20.6	19.9	6.1
40	20.6	19.9	6.1
45	20.5	19.9	6.1
50	20.5	19.8	6.0
55	20.5	19.8	6.0

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$CaCl_2$ 2 mM	CaC_{14}+$CaCl_2$ 5 mM
	pH = 5.28	pH = 5.40	pH = 4.73
60	20.5	19.8	6.0
65	20.5	19.8	6.0
70	20.5	19.8	5.9
75	20.5	19.8	5.9
80	20.5	19.8	5.9
85	20.5	19.8	5.8
90	20.5	19.7	5.8
95	20.5	19.6	5.8
100	20.5	19.6	5.8
105	20.4	19.6	5.7
110	20.4	19.5	5.7
115	20.4	19.5	5.7
120	20.4	19.4	5.6
125	20.4	19.4	5.6
130	20.4	19.3	5.6
135	20.4	19.3	5.6
140	20.4	19.2	5.6
145	20.4	19.2	5.5
150	20.4	19.2	5.5
155	20.4	19.2	5.5
160	20.4	19.2	5.5
165	20.3	19.1	5.5
170	20.3	19.1	5.5
175	20.3	19.1	5.5
180	20.3	19.1	5.5
185	20.3	19.1	5.5
190	20.3	19.1	5.5
195	20.3	19.0	5.5
200	20.3	19.0	5.5
205	20.3	19.0	5.5
210	20.3	19.0	5.5
215	20.3	19.0	5.4
220	20.3	19.0	5.4
225	20.3	19.0	5.4
230	20.2	19.0	5.4
235	20.2	18.9	5.4
240	20.2	18.9	5.4
245	20.2	18.9	5.4
250	20.2	18.8	5.4

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$CaCl_2$ 2 mM	CaC_{14}+$CaCl_2$ 5 mM
	pH = 5.28	pH = 5.40	pH = 4.73
255	20.2	18.8	5.4
260	20.2	18.8	5.3
265	20.2	18.8	5.3
270	20.1	18.7	5.3
275	20.1	18.7	5.3
280	20.1	18.7	5.3
285	20.1	18.7	5.3
290	20.1	18.7	5.3
295	20.1	18.7	5.3
300	20.1	18.7	5.3
305	20.1	18.6	5.3
310	20.1	18.6	5.3
315	20.1	18.6	5.3
320	20.1	18.6	5.3
325	20.1	18.5	5.3
330	20.1	18.5	5.3
335	20.0	18.5	5.3
340	20.0	18.4	5.3
345	20.0	18.4	5.3
350	20.0	18.4	5.3
355	20.0	18.4	5.3
360	20.0	18.4	5.3

Table E-3 The effect of hardness tolerance on the foaming properties of SDS solution in the presence of CaC_{22}.

Time (min)	CaC22 0.5 mM	CaC22+CaCl2 2 mM	CaC22+CaCl2 5 mM
	pH = 5.15	pH = 6.03	pH = 5.56
0	22.5	22.0	10.8
1	20.9	19.8	8.4
2	20.6	19.5	7.3
3	20.3	19.3	6.5
4	20.1	19.1	5.7
5	20.0	19.0	5.1
10	18.2	18.1	3.8
15	14.7	17.1	3.0

Time (min)	CaC22 0.5 mM	CaC22+CaCl2 2 mM	CaC22+CaCl2 5 mM
	pH = 5.15	pH = 6.03	pH = 5.56
20	12.2	12.8	2.8
25	9.2	7.8	2.5
30	7.7	6.3	2.4
35	6.2	5.1	2.3
40	5.4	4.8	2.3
45	5.0	3.8	2.3
50	4.5	3.5	2.3
55	4.0	3.4	2.3
60	3.4	3.4	2.3
65	3.1	3.4	2.3
70	2.9	3.3	2.2
75	2.8	3.3	2.2
80	2.8	3.3	2.2
85	2.8	3.2	2.2
90	2.8	3.1	2.2
95	2.8	3.1	2.2
100	2.8	3.1	2.2
105	2.8	3.1	2.2
110	2.8	3.0	2.2
115	2.8	3.0	2.1
120	2.7	3.0	2.1
125	2.7	2.9	2.1
130	2.7	2.9	2.1
135	2.6	2.8	2.1
140	2.6	2.8	2.1
145	2.6	2.7	2.1
150	2.6	2.7	2.1
155	2.6	2.7	2.1
160	2.6	2.6	2.0
165	2.5	2.6	2.0
170	2.5	2.6	2.0
175	2.5	2.6	2.0
180	2.5	2.5	2.0
185	2.5	2.5	2.0
190	2.5	2.5	2.0
195	2.5	2.4	2.0
200	2.5	2.4	2.0
205	2.4	2.3	2.0
210	2.4	2.3	2.0

Time (min)	CaC22 0.5 mM	CaC22+CaCl2 2 mM	CaC22+CaCl2 5 mM
	pH = 5.15	pH = 6.03	pH = 5.56
215	2.4	2.2	2.0
220	2.4	2.2	1.9
225	2.4	2.2	1.9
230	2.4	2.1	1.9
235	2.4	2.1	1.9
240	2.4	2.0	1.9
245	2.3	2.0	1.9
250	2.3	2.0	1.9
255	2.3	2.0	1.9
260	2.3	2.0	1.9
265	2.3	2.0	1.9
270	2.2	1.9	1.8
275	2.2	1.9	1.8
280	2.2	1.9	1.8
285	2.2	1.9	1.8
290	2.2	1.9	1.8
295	2.2	1.9	1.8
300	2.2	1.9	1.8
305	2.2	1.9	1.8
310	2.2	1.9	1.8
315	2.2	1.9	1.8
320	2.2	1.9	1.8
325	2.2	1.9	1.8
330	2.2	1.9	1.8
335	2.1	1.9	1.8
340	2.1	1.9	1.8
345	2.1	1.9	1.8
350	2.1	1.9	1.8
355	2.1	1.9	1.8
360	2.1	1.9	1.8

Appendix F : The effect of $NaHCO_3$ on the foaming properties of SDS solution in the presence of calcium soaps

Concentration of SDS = 10 mM

Concentration of calcium soap = 0.5 mM

Temperature = 30°C

Table F-1 The effect of $NaHCO_3$ on the foaming properties of SDS in the presence of CaC_{14}.

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$NaHCO_3$ 50 ppm	CaC14+$NaHCO_3$ 100 ppm
	pH = 5.28	pH = 6.70	pH = 6.89
0	23.4	24.2	24.5
1	21.3	22.2	22.4
2	21.0	21.9	22.2
3	20.9	21.8	22.1
4	20.8	21.8	22.0
5	20.8	21.8	22.0
10	20.7	21.5	21.8
15	20.7	21.3	21.7
20	20.7	21.3	21.6
25	20.6	21.3	21.6
30	20.6	21.3	21.6
35	20.6	21.2	21.6
40	20.6	21.1	21.5
45	20.5	21.1	21.4
50	20.5	21.1	21.4
55	20.5	21.1	21.4
60	20.5	21.1	21.4
65	20.5	21.1	21.4
70	20.5	21.0	21.4
75	20.5	21.0	21.4

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$NaHCO_3$ 50 ppm	CaC14+$NaHCO_3$ 100 ppm
	pH = 5.28	pH = 6.70	pH = 6.89
80	20.5	21.0	21.4
85	20.5	21.0	21.3
90	20.5	21.0	21.3
95	20.5	21.0	21.3
100	20.5	21.0	21.3
105	20.4	21.0	21.3
110	20.4	21.0	21.3
115	20.4	21.0	21.3
120	20.4	21.0	21.3
125	20.4	21.0	21.3
130	20.4	21.0	21.3
135	20.4	20.9	21.3
140	20.4	20.9	21.3
145	20.4	20.9	21.3
150	20.4	20.9	21.3
155	20.4	20.9	21.2
160	20.4	20.9	21.2
165	20.3	20.9	21.2
170	20.3	20.9	21.2
175	20.3	20.9	21.2
180	20.3	20.9	21.2
185	20.3	20.8	21.2
190	20.3	20.8	21.2
195	20.3	20.8	21.2
200	20.3	20.8	21.2
205	20.3	20.8	21.2
210	20.3	20.8	21.2
215	20.3	20.8	21.2
220	20.3	20.8	21.2
225	20.3	20.8	21.2
230	20.2	20.8	21.2
235	20.2	20.8	21.2

Time (min)	CaC_{14} 0.5 mM	CaC_{14}+$NaHCO_3$ 50 ppm	CaC14+$NaHCO_3$ 100 ppm
	pH = 5.28	pH = 6.70	pH = 6.89
240	20.2	20.8	21.2
245	20.2	20.8	21.2
250	20.2	20.8	21.2
255	20.2	20.7	21.2
260	20.2	20.7	21.2
265	20.2	20.7	21.2
270	20.1	20.7	21.2
275	20.1	20.7	21.2
280	20.1	20.7	21.2
285	20.1	20.7	21.2
290	20.1	20.7	21.2
295	20.1	20.7	21.2
300	20.1	20.7	21.2
305	20.1	20.7	21.2
310	20.1	20.7	21.2
315	20.1	20.7	21.2
320	20.1	20.7	21.2
325	20.1	20.7	21.2
330	20.1	20.7	21.2
335	20.0	20.7	21.2
340	20.0	20.7	21.2
345	20.0	20.7	21.2
350	20.0	20.7	21.2
355	20.0	20.7	21.2
360	20.0	20.7	21.2

Table F-2 The effect of $NaHCO_3$ on the foaming properties of SDS in the presence of CaC_{22}.

Time (min)	CaC_{22} 0.5 mM	CaC_{22}+$NaHCO_3$ 50 ppm	CaC_{22}+$NaHCO_3$ 100 ppm
	pH = 5.15	pH = 7.34	pH = 7.70
0	22.5	22.5	21.4
1	20.9	20.2	19.8
2	20.6	19.6	19.3
3	20.3	19.3	19.1
4	20.1	19.2	18.7
5	20.0	19.0	18.5
10	18.2	18.8	17.8
15	14.7	17.8	17.1
20	12.2	16.8	16.5
25	9.2	16.0	16.0
30	7.7	15.3	15.7
35	6.2	14.8	15.4
40	5.4	14.5	15.1
45	5.0	14.1	14.7
50	4.5	13.9	14.5
55	4.0	13.6	14.5
60	3.4	13.3	14.5
65	3.1	13.2	14.4
70	2.9	13.0	14.4
75	2.8	12.8	14.3
80	2.8	12.5	14.2
85	2.8	12.3	14.1
90	2.8	12.0	14.0
95	2.8	11.7	14.0
100	2.8	11.4	13.9
105	2.8	11.0	13.9
110	2.8	10.7	13.8
115	2.8	10.3	13.8
120	2.7	10.0	13.8

Time (min)	CaC_{22} 0.5 mM	CaC_{22}+$NaHCO_3$ 50 ppm	CaC_{22}+$NaHCO_3$ 100 ppm
	pH = 5.15	pH = 7.34	pH = 7.70
125	2.7	9.6	13.8
130	2.7	9.3	13.7
135	2.6	8.9	13.7
140	2.6	8.5	13.7
145	2.6	8.1	13.7
150	2.6	7.6	13.7
155	2.6	7.2	13.6
160	2.6	7.0	13.6
165	2.5	6.8	13.6
170	2.5	6.6	13.4
175	2.5	6.4	13.3
180	2.5	6.3	13.2
185	2.5	6.0	13.2
190	2.5	5.7	13.2
195	2.5	5.3	13.1
200	2.5	5.1	13.1
205	2.4	5.0	13.0
210	2.4	4.8	12.9
215	2.4	4.7	12.9
220	2.4	4.6	12.8
225	2.4	4.6	12.7
230	2.4	4.5	12.7
235	2.4	4.5	12.6
240	2.4	4.4	12.5
245	2.3	4.4	12.5
250	2.3	4.3	12.4
255	2.3	4.2	12.4
260	2.3	4.0	12.3
265	2.3	4.0	12.2
270	2.2	3.9	12.2
275	2.2	3.9	12.2
280	2.2	3.8	12.1

Time (min)	CaC_{22} 0.5 mM	CaC_{22}+$NaHCO_3$ 50 ppm	CaC_{22}+$NaHCO_3$ 100 ppm
	pH = 5.15	pH = 7.34	pH = 7.70
285	2.2	3.7	12.1
290	2.2	3.5	12.1
295	2.2	3.4	12.0
300	2.2	3.3	12.0
305	2.2	3.2	12.0
310	2.2	3.1	12.0
315	2.2	3.0	12.0
320	2.2	2.9	12.0
325	2.2	2.8	12.0
330	2.2	2.7	12.0
335	2.1	2.6	12.0
340	2.1	2.5	11.9
345	2.1	2.4	11.9
350	2.1	2.4	11.9
355	2.1	2.4	11.9
360	2.1	2.4	11.9

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