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APPENDICES

APPENDIX A

Experimental Data of Preparation of Stock Solutions and CMC Measurement

Table A-1 Preparation of the solution in various ratios and limitation of experiment.

SDS/SO = 5/95 , Volume = 20 ml

Inital [SO]	SO 0.1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M
Inital [SDS]	SDS 0.01M	SDS 0.01M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.5 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
V _{sds} /V _{so}	5.26/10.0	10.53/2.0	2.105/4.0	3.16/6.0	4.21/8.0	5.26/10	6.32/12	7.37/7	8.42/8.0	9.47/9	2.105/10.0

SDS/SO = 10/90 , Volume = 20 ml

Inital [SO]	SO 0.1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M
Inital [SDS]	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
V _{sds} /V _{so}	1.11/10.0	2.22/2.0	4.44/4.0	6.67/6.0	8.89/8.0	11.11/5.0	13.33/6.0	3.11/14	3.56/8.0	4.0/9.0	4.44/10.0

SDS/SO = 20/80 , Volume = 20 ml

Inital [SO]	SO 0.1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M
Inital [SDS]	SDS 0.1 M	SDS 0.1 M	SDS 0.1 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
V _{sds} /V _{so}	2.5/10.0	5.0/2.0	10.0/4.0	3.0/6.0	4.0/8.0	5.0/10.0	6.0/12.0	7-Jul	8.0/8.0	9.0/9.0	10.0/10.0

SDS/SO = 40/60 , Volume = 20 ml

Inital [SO]	SO 0.1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 3 M	SO 3 M
Inital [SDS]	SDS 0.1 M	SDS 0.1 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.5 M	SDS 0.8 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
V _{sds} /V _{so}	6.67/10	13.33/2	5.33/2	8.0/6.0	10.67/8.0	13.33/5.0	6.0/10.0	9.33/7	10.67/8.0	12.0/6.0	13.33/6.67

SDS/SO = 60/40 , Volume = 20 ml

Initial [SO]	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M
Initial [SDS]	SDS 0.1 M	SDS 0.1 M	SDS 0.5 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1
V _{SDS} /V _{SO}	15.0/1.0	6.0/2.0	12.0/4.0	9.0/6.0	12.0/8.0	15.0/5.0	18.0/6.0	24.0/8.0	30.0/10.0

SDS/SO = 80/20 , Volume = 20 ml

Initial [SO]	SO 0.1 M	SO 1 M	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M
Initial [SDS]	SDS 0.5 M	SDS 0.5 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1
V _{SDS} /V _{SO}	8.0/10.0	16.0/2.0	16.0/4.0	24.0/3.0	32.0/4.0	40.0/5.0	48.0/6.0	64.0/8.0	80.0/10.0

SDS/SO = 90/10 , Volume = 20 ml

Initial [SO]	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M
Initial [SDS]	SDS 0.5 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1
V _{SDS} /V _{SO}	18.0/1.0	18.0/1.0	36.0/2.0	54.0/3.0	72.0/4.0	90.0/5.0	108.0/6.0	144.0/8.0	180.0/1.0

SDS/SO = 95/5 , Volume = 20 ml

Initial [SO]	SO 1 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M	SO 2 M
Initial [SDS]	SDS 0.01M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M	SDS 1 M
[SO] (M)	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1
V _{SDS} /V _{SO}	19.0/1.0	38.0/1.0	76.0/2.0	114/3.0	152/4.0	190/5.0	228/6.0	304/8.0	380/10.0

Table A-2 The measured and calculated CMC value (CMC_{mix}) at different pH and different mole ratios for the mixture of SO and SDS.

Mole fraction of Soap in the mixture	CMC _{mix} (M)			
	pH 9		pH 7	
	measurement	calculation	measurement	calculation
pure SDS	7.8×10^{-3}	7.8×10^{-3}	7.6×10^{-3}	7.6×10^{-3}
0.6	1.86×10^{-1}	1.89×10^{-2}	1.6×10^{-1}	1.83×10^{-2}
0.8	2.5×10^{-1}	3.58×10^{-2}	2.3×10^{-1}	3.44×10^{-2}
0.9	1.6×10^{-1}	8.64×10^{-3}	-	8.42×10^{-3}
0.95	2.3×10^{-1}	8.2×10^{-3}	-	8×10^{-3}
pure SO	3.5×10^{-1}	3.5×10^{-1}	2.95×10^{-1}	2.95×10^{-1}

APPENDIX B

Experimental Data of Phase Boundary

Table B-1 The points on the phase boundary for SO at pH 9 , T = 30°C

Initial concentration (M)		Residual concentration		% of SO precipitated	Ksp (M ³)
SO	Calcium	SO	Calcium		
3.96×10^{-2}	2.02×10^{-3}	2.96×10^{-2}	1.05×10^{-3}	25.24	3.11×10^{-5}
9.63×10^{-2}	3.37×10^{-4}	6.89×10^{-2}	1.56×10^{-4}	28.46	1.07×10^{-5}
4.42×10^{-1}	1.13×10^{-4}	3.2×10^{-1}	5.65×10^{-5}	27.53	1.81×10^{-5}
4.92×10^{-1}	1.28×10^{-4}	3.7×10^{-1}	6.4×10^{-5}	24.88	-
6.27×10^{-1}	3.73×10^{-4}	4.88×10^{-1}	1.87×10^{-5}	22.16	-
9.34×10^{-1}	6.54×10^{-4}	7.0×10^{-1}	3.27×10^{-5}	25.11	-

Table B-2 The points on the phase boundary for SO at pH 7 , T = 30°C

Initial concentration (M)		Residual concentration (M)		% of SO precipitated	Ksp (M ³)
SO	Calcium	SO	Calcium		
3.18×10^{-2}	1.8×10^{-3}	2.47×10^{-2}	9.3×10^{-3}	22.45	2.29×10^{-5}
5.8×10^{-2}	4.67×10^{-4}	4.37×10^{-2}	2.28×10^{-4}	24.65	9.96×10^{-6}
9.11×10^{-1}	2.1×10^{-4}	6.84×10^{-1}	8.51×10^{-5}	24.86	5.83×10^{-6}
1.25×10^{-1}	7.85×10^{-4}	9.3×10^{-1}	4.72×10^{-5}	25.61	4.39×10^{-6}
3.14×10^{-1}	9.71×10^{-5}	2.27×10^{-1}	4.25×10^{-6}	27.55	-
3.98×10^{-1}	1.86×10^{-4}	3.04×10^{-1}	2.01×10^{-5}	23.56	-

Table B-3 The points on the phase boundary for the mixture of SO and SDS
at mole ratio of SDS/SO = 5/95 , at pH 9 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.39×10^{-2}	1.78×10^{-3}	3.05×10^{-3}	2.3×10^{-2}	1.41×10^{-3}	1.68×10^{-3}	32.2	20.89
7.32×10^{-2}	3.85×10^{-3}	2.56×10^{-3}	4.75×10^{-2}	2.98×10^{-3}	1.22×10^{-3}	35.1	22.65
1.58×10^{-1}	8.31×10^{-3}	2.01×10^{-3}	1.0×10^{-1}	6.54×10^{-3}	9.88×10^{-4}	36.5	21.36
2.6×10^{-1}	1.37×10^{-2}	1.3×10^{-3}	1.77×10^{-1}	1.04×10^{-2}	6.31×10^{-4}	31.64	23.87
3.49×10^{-1}	1.83×10^{-2}	1.18×10^{-3}	2.39×10^{-1}	1.4×10^{-2}	5.74×10^{-4}	31.55	25.63
4.25×10^{-1}	2.24×10^{-2}	1.4×10^{-3}	2.83×10^{-1}	1.64×10^{-2}	6.99×10^{-4}	33.25	26.54
4.8×10^{-1}	2.52×10^{-2}	1.88×10^{-3}	2.93×10^{-1}	1.82×10^{-2}	9.16×10^{-4}	38.9	27.96
6.08×10^{-1}	3.2×10^{-2}	2.32×10^{-3}	3.87×10^{-1}	2.34×10^{-2}	1.21×10^{-3}	36.27	26.77
7.12×10^{-1}	3.75×10^{-2}	2.78×10^{-3}	4.63×10^{-1}	2.68×10^{-2}	1.5×10^{-3}	35.02	28.55

Table B-4 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 5/95 , at pH 7 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.91×10^{-2}	2.06×10^{-3}	2.15×10^{-3}	2.59×10^{-2}	1.58×10^{-3}	1.14×10^{-3}	31.1	23.0
8.67×10^{-2}	4.56×10^{-3}	9.97×10^{-4}	5.88×10^{-2}	3.53×10^{-3}	5.02×10^{-4}	32.2	22.62
1.88×10^{-1}	9.88×10^{-3}	5.63×10^{-4}	1.27×10^{-1}	7.24×10^{-3}	2.87×10^{-4}	32.51	26.75
2.79×10^{-1}	1.46×10^{-2}	5.1×10^{-4}	1.7×10^{-1}	1.1×10^{-2}	2.53×10^{-4}	39.3	24.89

Table B-5 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 10/90 , at pH 9 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.66×10^{-2}	4.07×10^{-3}	2.48×10^{-3}	2.47×10^{-2}	2.96×10^{-3}	8.24×10^{-3}	32.6	27.14
7.57×10^{-2}	8.41×10^{-3}	2.31×10^{-3}	4.91×10^{-2}	6.42×10^{-3}	1.25×10^{-3}	35.11	23.65
1.53×10^{-1}	1.7×10^{-2}	2.26×10^{-3}	1.02×10^{-1}	1.24×10^{-2}	1.1×10^{-4}	33.22	26.63
2.44×10^{-1}	2.71×10^{-2}	1.83×10^{-3}	1.55×10^{-1}	1.92×10^{-2}	9.73×10^{-4}	36.3	29.14
3.17×10^{-1}	3.52×10^{-2}	1.98×10^{-3}	2.23×10^{-1}	2.7×10^{-2}	9.95×10^{-4}	29.7	23.35
3.88×10^{-1}	4.32×10^{-2}	2.14×10^{-3}	2.59×10^{-1}	3.23×10^{-2}	1.18×10^{-3}	33.32	25.08
4.56×10^{-1}	5.07×10^{-2}	2.28×10^{-3}	2.9×10^{-1}	3.79×10^{-2}	1.22×10^{-3}	36.38	25.18
5.84×10^{-1}	6.48×10^{-2}	2.63×10^{-3}	4×10^{-1}	4.71×10^{-2}	1.4×10^{-3}	31.43	27.41
7.07×10^{-1}	7.86×10^{-2}	2.83×10^{-3}	4.8×10^{-1}	6.28×10^{-2}	1.51×10^{-3}	32.11	20.11

Table B-6 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 10/90 , at pH 7 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.98×10^{-2}	4.43×10^{-3}	1.99×10^{-3}	2.46×10^{-2}	3.38×10^{-3}	1.01×10^{-3}	38.4	23.57
8.75×10^{-2}	9.72×10^{-3}	9.18×10^{-4}	5.64×10^{-2}	7.3×10^{-3}	5.16×10^{-4}	35.47	24.89
1.85×10^{-1}	2.06×10^{-2}	6.94×10^{-4}	1.17×10^{-1}	1.55×10^{-2}	3.74×10^{-4}	36.63	24.6
2.75×10^{-1}	3.05×10^{-2}	5.97×10^{-4}	1.72×10^{-1}	2.34×10^{-2}	3.21×10^{-4}	37.2	23.57
3.8×10^{-1}	4.22×10^{-2}	4.27×10^{-4}	2.83×10^{-1}	3.24×10^{-2}	2.27×10^{-4}	25.5	23.31

Table B-7 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 20/80 , at pH 9 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.43×10^{-2}	8.58×10^{-3}	3.09×10^{-3}	2.34×10^{-2}	6.43×10^{-3}	1.29×10^{-3}	31.8	25.13
7.14×10^{-2}	1.78×10^{-2}	2.85×10^{-3}	5.1×10^{-2}	1.37×10^{-2}	1.8×10^{-3}	28.6	23.11
1.75×10^{-1}	4.38×10^{-2}	1.18×10^{-3}	1.11×10^{-1}	2×10^{-2}	7.56×10^{-4}	36.6	22.46
2.84×10^{-1}	7.09×10^{-2}	4.26×10^{-4}	1.92×10^{-1}	5.31×10^{-2}	3.39×10^{-4}	32.31	25.15
3.81×10^{-1}	9.52×10^{-2}	4.76×10^{-4}	2.48×10^{-1}	7.3×10^{-2}	2.52×10^{-4}	34.78	23.35
4.66×10^{-1}	1.16×10^{-1}	5.13×10^{-4}	3.14×10^{-1}	9.27×10^{-2}	2.96×10^{-4}	32.5	20.47
5.62×10^{-1}	1.41×10^{-1}	5.63×10^{-4}	3.5×10^{-1}	1×10^{-2}	3.66×10^{-4}	37.8	28.87
6.82×10^{-1}	1.71×10^{-1}	1.36×10^{-3}	4.37×10^{-1}	1.27×10^{-2}	3.98×10^{-4}	35.97	25.44
7.31×10^{-1}	1.83×10^{-1}	2.56×10^{-3}	4.73×10^{-1}	1.35×10^{-2}	4.52×10^{-4}	35.24	26.1

Table B-8 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 20/80 , at pH 7 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
3.73×10^{-2}	9.34×10^{-3}	2.5×10^{-3}	2.28×10^{-2}	7.04×10^{-3}	1.71×10^{-3}	38.8	24.65
7.53×10^{-2}	1.88×10^{-2}	2.45×10^{-3}	4.98×10^{-2}	1.39×10^{-2}	1.88×10^{-3}	33.9	26.03
1.76×10^{-1}	4.4×10^{-2}	1.06×10^{-3}	1.16×10^{-1}	3.34×10^{-2}	6.59×10^{-4}	33.9	24.01
2.7×10^{-1}	6.76×10^{-2}	9.02×10^{-4}	1.86×10^{-1}	4.73×10^{-2}	6.82×10^{-4}	31.12	30.11
3.7×10^{-1}	9.25×10^{-2}	6.01×10^{-4}	2.37×10^{-1}	6.99×10^{-2}	2.9×10^{-4}	36.04	24.41
4.57×10^{-1}	1.14×10^{-1}	7.76×10^{-4}	2.88×10^{-1}	8.77×10^{-2}	4.07×10^{-4}	36.87	23.2
5.27×10^{-1}	1.32×10^{-1}	1.1×10^{-3}	3.42×10^{-1}	9.93×10^{-2}	5.07×10^{-4}	35.06	24.74

Table B-9 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 40/60 , at pH 9 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
2.8×10^{-2}	1.87×10^{-2}	4.4×10^{-3}	1.86×10^{-2}	1.41×10^{-3}	1.17×10^{-3}	33.47	24.48
8.31×10^{-2}	5.54×10^{-2}	1.66×10^{-3}	5.36×10^{-2}	4.23×10^{-2}	8.42×10^{-4}	35.51	23.75
1.69×10^{-1}	1.13×10^{-1}	1.44×10^{-3}	1.04×10^{-1}	8.54×10^{-2}	5.85×10^{-4}	38.3	24.41
2.76×10^{-1}	1.84×10^{-1}	6.91×10^{-4}	1.83×10^{-1}	1.4×10^{-1}	4.39×10^{-4}	33.62	24.17
3.39×10^{-1}	2.26×10^{-1}	1.27×10^{-3}	2.38×10^{-1}	1.66×10^{-1}	7.74×10^{-4}	29.9	26.46
4.16×10^{-1}	2.77×10^{-1}	1.54×10^{-3}	2.56×10^{-1}	2.07×10^{-1}	8.12×10^{-4}	38.39	25.34
4.85×10^{-1}	3.24×10^{-1}	1.74×10^{-3}	3.32×10^{-1}	2.39×10^{-1}	8.94×10^{-4}	31.57	26.11
5.82×10^{-1}	3.88×10^{-1}	2.62×10^{-3}	3.97×10^{-1}	2.91×10^{-1}	1.47×10^{-4}	31.8	25.13

Table B-10 The points on the phase boundary for the mixture of SO and SDS at mole ratio of SDS/SO = 40/60 , at pH7 , T = 30°C

Initial concentration (M)			Residual concentration (M)			% of SO precipitated	% of SDS precipitated
SO	SDS	Calcium	SO	SDS	Calcium		
2.52×10^{-2}	1.68×10^{-2}	4.85×10^{-3}	1.68×10^{-2}	1.28×10^{-3}	2.29×10^{-3}	33.12	23.64
7.67×10^{-2}	5.11×10^{-2}	2.11×10^{-3}	4.83×10^{-2}	3.83×10^{-2}	1.12×10^{-3}	37.0	25.18
1.53×10^{-1}	1.02×10^{-1}	1.91×10^{-3}	1.06×10^{-1}	7.42×10^{-2}	1.1×10^{-3}	30.6	27.16
2.38×10^{-1}	1.58×10^{-1}	1.58×10^{-3}	1.59×10^{-1}	1.2×10^{-1}	7.94×10^{-4}	33.1	24.31
3.15×10^{-1}	2.1×10^{-1}	1.97×10^{-3}	1.97×10^{-1}	1.55×10^{-1}	1.02×10^{-3}	37.36	26.31
3.81×10^{-1}	2.54×10^{-1}	2.17×10^{-3}	2.63×10^{-1}	1.9×10^{-1}	1.05×10^{-3}	30.73	25.4
4.44×10^{-1}	2.96×10^{-1}	2.33×10^{-3}	2.84×10^{-1}	2.19×10^{-1}	1.22×10^{-3}	35.98	26.11

APPENDIX C

Experiment Data of Acid Soap at pH 7

Table C-1 Formation of acid soap at pH 7

Mole ratio of SDS/SO	Concentration of SO where acid soap forms
0 / 100	0
5 / 95	3×10^{-1}
10 / 90	4×10^{-1}
20 / 80	6×10^{-1}
40 / 60	6×10^{-1}

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