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"SOLUBILITY AND TIE LINE DATA FOR THE SYSTEM SEA WATER – XYLENE – n – BUTANOL"

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ABSTRACT

Ternary equilibrium data for the system Sea Water – Xylene–n–Butanol were determined at 25°C. The maximum solubility of n–Butanol in sea water was found to be 4.763% at room temperature. Xylene was found to be practically insoluble in sea water. The distribution coefficient between the xylene phase and the water phase was found to be 1.7.

Xylene is recommended as a solvent for alcohols and other organic materials from sea water.

INTRODUCTION

Various solvent systems have been used to extract organic materials from dilute aqueous solutions. Only a few of these solvents [1] have distribution coefficients greater than 1. Although xylenes have higher boiling points than toluene and benzene, they are not widely used in extraction applications.

Little has been published about xylene systems. It seemed warranted to measure the ternary equilibrium data for some systems containing sea water and xylene to provide such data required in liquid extraction applications. Aniline, methanol and n–butanol were used as solutes in this investigation.

EXPERIMENTAL

Aniline, methanol, n-butanol and xylene used were all chemicals produced by BDH Chemicals Ltd., Poole, England. The xylene was a mixture of ortho, meta

and para. Sea water was obtained from the Arabian Gulf without any purification. Double distilled water was produced in the department and used in some experiments.

Some properties of the liquids used are given in Table 1.

Table 1 - Physical data for the Liquids used.

Item	Water	Sea-water	Xylene	Aniline	Methanol	n-Butanol
M. W.	18	18	106.16	93.12	32.04	74.12
Formula	H_2O	H_2O	$C_6H_4(CH_3)_2$	$C_6H_5NH_2$	CH_3OH	C_4H_9OH
Density gm/ml	1.00	1.004	0.86	1.022	0.792	0.81
Boiling point C	100		144	184.4	64.7	117
Rn*	1.334	1.3342	1.4973	1.5863	1.3288	1.39970

* Refractive index

Solubility Data

The solubility data for water – xylene systems containing aniline, methanol and n-butanol were determined by the titration method [2]. The water phase data were determined by titrating different mixtures of known composition of water and the solute with xylene until the appearance of first permanent turbidity. The xylene phase data were produced by titrating different mixtures of known composition of xylene and the solute with water until the appearance of first permanent turbidity.

Equilibrium Data

Equilibrium data were tried to be determined for these systems at 25°C. Three thermostatically controlled Smith-Bonner Cells [3] were used for this purpose. Equal amounts of water and xylene were stirred with a certain weight of solute for 4 hours. The mixture was then allowed to settle for 24 hours. The phases were separated, weighed and the solute content in each phase was determined by Abbe' refractometer.

RESULTS AND DISCUSSION

The solubility data for the systems containing aniline, methanol and n-butanol are displayed in Tables 2, 3 and 4. Tables 2 and 3 show that the change in refractive indices by the increase of the amount of solute was very small. For such systems, it might be recommended to use other techniques than the refractive index. Equilibrium data determination for the system containing aniline were not successful for this reason. The methanol system introduced other difficulties in tie line determination. It was observed that at relatively high solute concentrations separation of phases was very difficult. This may be attributed to its isopycnic behaviour which has been reported by Francis [4]. That is, the two phases have nearly identical densities. From the few points determined it was found that the distribution coefficient was very small, about 0.009. This suggests that xylene cannot be used economically for extracting methanol from sea water.

Table 2 - Solubility data of the System Water (A) - Xylene (B) - Aniline (C) at 25 C.

3 - Component System			Rn*
A %	B %	C %	
100.0	0.0	0.0	1.3343
99.925	0.085	0.0	1.3345
99.417	0.085	0.497	1.3358
98.915	0.096	0.989	1.3367
98.418	0.105	1.476	1.3379
97.926	0.116	1.959	1.3389
97.438	0.126	2.436	1.3401
0.170	97.561	2.269	1.4981
0.156	98.132	1.712	1.4980
0.143	98.709	1.148	1.4975
0.115	99.307	0.577	1.4971

* Refractive index.

Table 3 - Solubility data of the System Water (A) - Xylene (B) - Methanol (C) at 25 C.

3 - Component System			Rn*
A %	B %	C %	
99.950	0.050	0.0	1.3348
97.441	0.122	2.437	1.3351
95.164	0.191	4.645	1.3355
90.853	0.228	8.919	1.3368
84.055	0.317	15.628	1.3380
71.920	0.362	27.717	1.3410
56.469	0.427	43.103	1.3440
0.723	57.009	42.269	1.4500
0.592	66.779	32.629	1.4675
0.406	80.527	19.067	1.4775
0.360	84.164	15.486	1.4825
0.333	88.124	11.543	1.4865
0.228	90.640	9.132	1.4875
0.049	97.976	1.974	1.4955
0.025	99.975	0.0	1.4976

* Refractive index.

Table 4 - Solubility data of the System Sea Water (A) - Xylene (B) - n-Butanol (C) at 25 C.

3 - Component System			Rn*
A %	B %	C %	
100.0	0.0	0.0	1.3420
99.015	0.0	0.985	1.3432
98.043	0.0	1.957	1.3442
96.899	0.0	3.101	1.3453
95.785	0.0	4.215	1.3465
95.238	0.0	4.762	1.3465
0.0	81.433	18.567	1.4762
0.0	89.286	10.714	1.4847
0.0	92.593	7.407	1.4889
0.0	93.458	6.542	1.4903
0.0	94.340	5.660	1.4915
0.0	95.238	4.762	1.4929
0.0	96.154	3.846	1.4937
0.0	98.039	1.961	1.4951
0.0	100.0	0.0	1.4973

* Refractive index.

The equilibrium data for the n-butanol in sea water – xylene mixtures are given in Table 5. Plotting these data gave a linear relationship for the distribution coefficient, K, in the range of interest. This coefficient was found to be about 1.7. This compared well with that in toluene, K = 1.176 [1], and benzene, K = 1.263 [5], in distilled water. However, the salt content may have a salting out effect which is demonstrated by the higher value of the distribution coefficient obtained when using sea water in this work.

Table 5 - Tie Lines Data for the System Sea Water (A) - Xylene (B) - n-Butanol (C) at 25 C.

3 - Component System			Percentage of n-Butanol in			
Sea-water (A)	Xylene (B)	n-Butanol (C)	Sea water phase		Xylene phase	
%	%	%	x	Rn	y	Rn
49.901	49.701	0.398	0.65	1.3427	0.20	1.4970
49.505	49.505	0.990	0.95	1.3430	0.70	1.4965
49.997	48.452	1.550	1.50	1.3435	1.75	1.4953
48.828	48.828	2.344	2.06	1.3442	2.58	1.4944
47.892	48.277	3.831	2.45	1.3446	5.60	1.4910

This shows that xylene is practically a possible extracting solvent for n-butanol from water and may also be used for higher alcohols.

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