CHAPTER–(4)

EXPERIMENTAL

CHAPTER - 4

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4.0.0 ABSTRACT: This Chapter deals with all the experimental observations recorded in this investigation. It has been devided in two parts as under:-

Part-I : Quaternary liquid-liquid phase equilibrium data obtained for systems involving two solvents-Dimethyl formamide (Dmf) and Dimethyl sulfoxide (Dmso) includes the following.:-

(i) Different systems consisting of B/T/X-H/H'/O-Dmf-W under different sets of conditions.

(ii) Different systems consisting of B/T/X-H/H'/O-Dmso-W under different sets of conditions.

Inclusive of different variations totally 45 systems have been investigated using mixed solvent- Dmf+W.

Inclusive of different variations totally 45 systems have been investigated using mixed solvent- Dmso+W.

Part-II :Liquid-liquid extraction of aromatics has been investigated in a packed column using mixed solvent Dmf+W as well as mixed solvent Dmso+W.

Prime parameters varied include – Solvent to feed ratio (S/F), Dispersed phase flow rate (Vd) and Continuous phase flow rate (Vc) . Column diameter has also been varied and multi stage operation has been also investigated.

For mixed solvent – Dmf+W , all packed column experimental runs were taken in winter season at 30 ^{0}C.

For mixed solvent – Dmso+W , all packed column experimental runs were taken in winter season at 40 ^{0}C .

4.1.0 Quaternary liquid-liquid phase equilibrium data:-

4.1.1 Materials/ Chemicals:

All the chemicals used in the present investigation were of laboratory reagent grade and were further purified by fractional distillation.[155] The ternary / quaternary liquid-liquid phase equilibrium data i.e. mutual solubility data and tie line data – have been obtained for the various systems consisting of the following solutes, non-solutes, solvents and antisolvent:

Solutes – Benzene, Toluene and P-Xylene
Non-Solutes – Hexane, Heptane and Octane
Solvents – Dimethyl sulphoxide (Dmso) and Dimethyl formamide (Dmf)
Antisolvent – Water

All the relevant physical properties of materials used in this investigation have been compared with the values reported in the literature in Table – (A) . As could be seen from Table – (A), experimental values and the values reported in the literature[156-158] of different physical properties are comparable. Hence, all these chemicals have been used in this investigation for obtaining ternary and quaternary liquid-liquid phase equilibrium data and subsequently obtaining data on mass transfer rates by performing a liquid – liquid extraction of aromatics in a packed column.

4.1.2 Experimental procedure:

In majority of the cases, it is essential to determine mutual solubility data and relevant solubility line and the tie lines by separate measurements. For the determination of solubility line, the titration method was used. The tie-lines were determined by preparing the known mixtures of three components such that overall compositions were within the heterogeneous region. The equilibrium was allowed to attain at constant temperature and two phases were sampled and analyzed.

Table-A

Physical properties of chemicals used at 30 °C

Chemical Used	Mole.Wt.	Formula	From Literature[156,157,158] B.P. °C	R.I.	Density gm/c.c	Visco C.P	Experimental B.P. °C	R.I.	Density gm/c.c	Visco C.P
Benzene	78.000	C_6H_6	80.1	1.4970	0.868	0.562	80.700	1.4920	0.891	0.560
Toluene	92.000	$C_6H_5CH_3$	112.0	1.4941	0.860	0.510	110.620	1.3753	0.866	0.501
P-Xylene	106.000	$C_6H_4(CH_3)_2$	138.3	1.4925	0.853	0.576	139.000	1.4907	0.856	0.590
n-Hexane	86.000	C_6H_{14}	69.0	1.3750	0.672	0.290	68.740	1.3753	0.670	0.298
Heptane	100.000	C_7H_{16}	98.2	1.3851	0.684	0.385	98.200	1.3851	0.687	0.388
Octane	114.230	C_8H_{18}	123.0	1.3900	0.690	-	126.000	1.3972	0.695	-
Dmf	73.090	$H.CO.N[CH_3]_2$	153.0	1.4232	0.950	0.802	154.000	1.4269	0.948	0.808
80% Dmf+20% W	-	–	-	-	-	-	115.000	1.4170	0.980	1.970
Dmso	78.130	$CH_3.SO.CH_3$	190.0	1.4768	1.096	1.825	189.000	1.4768	1.096	1.815
80% Dmso+20%W	-	-	-	-	-	-	188.000	1.4767	1.080	1.660
Water	18.000	H_2O	100.0	1.3300	1.000	0.998	100.000	1.3300	0.994	1.076

Note : Interfacial Tension of System -B + H + 80% Dmf+20% Water at 30°C= 0.390 Dynes/Cm..

(i) Mutual solubility data:

The points of mutual solubility data on the binodal curve were determined by titration method.[159] The tie line data were determined by analyzing the extract and raffinate phases by refractive index method. However, for a few typical cases, the analysis of extract and raffinate phases was done by washing method also. It was observed that the results obtained by both the methods were comparable. Hence, for simplicity, the refractive index method was used while obtaining all quaternary mutual solubility data.

The refractive index at each point of mutual solubility on the binodal curve was recorded to prepare the refractive index Vs. composition charts which could be utilized for estimating the compositions of extract and raffinate phase i.e. tie-line data. Plots of R.I. Vs. Composition are represented in Fig.E. 1-.1 to Fig.E. 1-.45 for extract phase composition and Fig.R. 1-.1 to Fig.R. 1-.45 for raffinate phase composition for solvent Dmf and Fig.E. 2-.1 to Fig.E. 2-.45 for extract phase composition and Fig.R. 2-.1 to Fig.R. 2-.45 for raffinate phase composition for solvent Dmso. All the relevant figures are depicted in Appendix-I.

(ii) Tie line data :

The tie line data can be determined [159] by preparing known synthetic mixtures of the three components such that the resulting composition lies in the heterogeneous region on the ternary diagram. The mixture is than agitated well in a constant temperature bath for one hour so that the equilibrium is attained and the two phases are allowed to separate by allowing them to settle for an hour. The two phases are then separated and analyzed to determine the compositions.

For few typical systems, the tie line data were determined by refractive index method as well as washing method reported by Alders[160] . It was observed that both of these methods gave comparable results. Hence, for simplicity, the refractive index method

was used to obtain tie-line data-composition of Extract and Raffinate phases - for the various systems.

4.1.3 Systems:

Quaternary liquid - liquid phase equilibrium data has been obtained at three different temperatures- 20^0 30^0 and 40^0 C with antisolvent concentration of water being varied from 0%, 10% and 20% for the following two Categories-

B/T/X-H/H'/O –Dmf-Water and B/T/X-H/H'/O –Dmso-Water:
Different systems investigated are as under:-

Category-(i): For mixed Solvent- Dmf+W:-

(1) Benzene + Hexane + Dmf + Water.
(2) Toluene + Hexane + Dmf + Water.
(3) Xylene + Hexane + Dmf + Water.
(4) Benzene + Heptane + Dmf + Water.
(5) Benzene + Octane + Dmf + Water.

Category-(ii): For mixed Solvent- Dmso+W:-

(6) Benzene + Hexane + Dmso + Water.
(7) Toluene + Hexane + Dmso + Water.
(8) Xylene + Hexane + Dmso + Water.
(9) Benzene + Heptane + Dmso + Water.
(10) Benzene + Octane + Dmso + Water.

4.1.4. Mutual solubility data:-

Experimental results for mutual solubility data using mixed solvent Dmf are reported in Tables - 1 to 15 for systems -1 to 5 by varying three fixed temperatures and three fixed anti solvent concentrations thus involving as such 45 systems.

Experimental results for mutual solubility data using mixed solvent Dmso are reported in Tables - 16 to 30 for systems -6 to 10 by varying three fixed temperatures and three fixed anti solvent concentrations thus involving as such 45 systems.

(I) Mutual Solubility Data Tables using solvent Dimethyl formamide (Dmf):

Mutual Solubility data for liquid-liquid extraction of aromatics for different systems consisting of aromatics-Benzene(B), Toluene(T) and Xylene(X) and aliphatics-Hexane(H), Heptane(Hept) and Octane(Oct) using solvent Dimethyl formamide (Dmf) and antisolvent Water(W) under different sets of conditions has been reported in Tables – 1to15.

Mutual Solubility data for the system-B-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 1,2 and 3 respectively.

Mutual Solubility data for the system-T-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 4,5 and 6 respectively.

Mutual Solubility data for the system-X-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 7,8 and 9 respectively.

Mutual Solubility data for the system-B-Hept-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 10,11 and 12 respectively.

Mutual Solubility data for the system-B-Oct-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 13,14 and 15 respectively.

(II) Mutual Solubility Data Tables using solvent Dimethyl Sulphoxide (Dmso):-

Mutual Solubility data for liquid-liquid extraction of aromatics for different systems consisting of aromatics-Benzene(B), Toluene(T) and Xylene(X) and aliphatics-Hexane(H), Heptane(Hept) and Octane(Oct) using solvent Dimethyl Sulphoxide (Dmso) and antisolvent Water(W) under different sets of conditions has been reported in Tables – 16 to 30.

Mutual Solubility data for the system-B-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 16,17 and 18 respectively.

Mutual Solubility data for the system-T-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 19,20 and 21 respectively.

Mutual Solubility data for the system-X-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 22,23 and 24 respectively.

Mutual Solubility data for the system-B-Hept-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 25,26 and 27 respectively.

Mutual Solubility data for the system-B-Oct-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 28,29 and 30 respectively.

4.1.5 Tie line data for Liquid-Liquid extraction of aromatics.

Experimental results for Tie line data using solvent Dmf are reported in Tables - 31 to 45 for systems -1 to 5 by varying three fixed temperatures and three fixed anti solvent concentrations thus involving as such 45 systems.

Experimental results for Tie line data using solvent Dmso are reported in Tables - 46 to 60 for systems -6 to 10 by varying three fixed temperatures and three fixed anti solvent concentrations thus involving as such 45 systems.

(I) Tie line Data Tables using solvent Dimethyl formamide (Dmf).

Tie line data for liquid-liquid extraction of aromatics for different systems consisting of aromatics-Benzene(B), Toluene(T) and Xylene(X) and aliphatics-Hexane(H), Heptane(Hept) and Octane(Oct) using solvent Dimethyl formamide (Dmf) and antisolvent Water(W) under different sets of conditions has been reported in Tables – 31 to 45.

Tie line data for the system-B-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 31,32 and 33 respectively.

Tie line data for the system-T-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 34,35 and 36 respectively.

Tie line data for the system-X-H-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 37,38 and 39 respectively.

Tie line data for the system-B-Hept-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 40,41 and 42 respectively.

Tie line data for the system-B-Oct-Dmf+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 43,44 and 45 respectively.

(II) Tie line Data Tables using solvent Dimethyl Sulphoxide (Dmso).

Tie line data for liquid-liquid extraction of aromatics for different systems consisting of aromatics-Benzene(B), Toluene(T) and Xylene(X) and aliphatics-Hexane(H), Heptane(Hept) and Octane(Oct) using solvent Dimethyl Sulphoxide (Dmso) and antisolvent Water(W) under different sets of conditions has been reported in Tables – 46 to 60

Tie line data for the system-B-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 46,47and 48 respectively.

Tie line data for the system-T-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 49,50 and 51 respectively.

Tie line data for the system-X-H-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 52, 53 and 54 respectively.

Tie line data for the system-B-Hept-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 55, 56 and 57 respectively.

Tie line data for the system-B-Oct-Dmso+W for temperatures 20^0,30^0 and 40^0 C with antisolvent concentration varied from 0%, 10% and 20% is reported in Tables - 58, 59 and 60 respectively.

Table- - 1

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmf(D) + Water(W) at 20°C

Sr.No.	%Dmf+W	$\%X_B$	$\%X_H$	$\%X_{Dmf+W}$	R . I .
1	100+0	00.000	95.369	04.361	1.3771
2		05.641	86.461	07.898	1.3810
3		10.791	83.719	05.490	1.3890
4		14.070	79.779	06.151	1.3900
5		17.681	71.899	10.542	1.3980
6		19.140	67.462	13.398	1.4025
7		00.000	12.906	87.094	1.4225
8		05.949	15.855	78.196	1.4250
9		11.003	16.683	72.314	1.4265
10		12.413	19.138	68.389	1.4280
11		14.544	21.731	63.725	1.4285
12		20.012	47.105	32.883	1.4310
13		22.134	24.310	53.556	1.4314
14	p	23.500	48.000	28.500	-
1	90+10	00.000	98.539	01.421	1.3758
2		23.991	72.608	03.401	1.3990
3		40.000	57.800	02.200	1.4180
4		65.522	33.049	01.429	1.4505
5		80.000	18.782	01.218	1.4710
6		99.428	00.000	00.572	1.4980
7		00.000	02.396	97.584	1.4230
8		15.000	10.000	75.000	1.4310
9		36.669	03.177	50.154	1.4438
10		50.000	08.000	42.000	1.4560
11		65.311	00.000	34.689	1.4700
1	80+20	00.000	96.657	03.373	1.3764
2		23.465	71.264	05.271	1.4002
3		46.165	52.572	01.263	1.4268
4		65.727	33.203	01.070	1.4478
5		83.472	15.843	00.685	1.4713
6		99.462	00.000	00.538	1.4969
7		00.000	01.084	98.916	1.4186
8		26.299	01.590	72.111	1.4351
9		37.388	00.000	62.042	1.4430

Table- - 2

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmf(D) + Water(w) at 30°C

Sr.No.	%Dmf+W	$\%X_B$	$\%X_H$	$\%X_{Dmf+W}$	R . I .
1	100+0	00.000	94.100	05.941	1.3750
2		08.000	81.087	11.013	1.3789
3		12.716	71.080	16.196	1.3870
4		14.739	60.239	25.022	1.3930
5		15.457	49.379	35.164	1.3970
6		16.002	36.049	47.949	1.4170
7		00.000	15.205	84.795	1.4145
8		08.769	22.794	59.137	1.4220
9		14.429	32.146	53.425	1.4236
10		16.096	39.802	44.102	1.4251
11	P	15.500	46.000	24.500	-
1	90+10	00.000	98.578	01.421	1.3700
2		23.895	72.319	03.786	1.3955
3		45.276	51.385	03.339	1.4160
4		64.678	32.624	02.698	1.4465
5		82.766	15.655	01.579	1.4700
6		97.243	00.000	02.757	1.4900
7		00.000	03.971	96.029	1.4180
8		22.457	16.114	61.429	1.4280
9		37.450	11.329	51.221	1.4380
10		44.872	10.491	44.637	1.4480
11		56.693	04.811	38.496	1.4575
12		64.100	00.000	35.900	1.4620
1	80+20	00.000	97.183	02.817	1.3700
2		23.730	71.832	04.428	1.3960
3		43.270	54.830	01.900	1.4170
4		66.353	32.930	00.712	1.4540
5		82.986	16.309	00.705	1.4700
6		99.135	00.000	00.865	1.4903
7		00.000	02.657	97.163	1.4140
8		26.274	01.478	72.248	1.4280
9		42.107	00.000	57.893	1.4396
10		37.500	00.500	62.000	1.4385

Table- - 3

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+W	%X_B	%X_H	%X_{Dmf+W}	R.I.
1	100+0	00.000	96.653	03.347	1.3741
2		10.704	77.231	12.065	1.3839
3		12.313	79.612	08.075	1.3836
4		12.907	67.537	19.555	1.3870
5		14.081	69.927	15.792	1.3908
6		19.800	72.714	07.486	1.3945
7		12.895	69.487	17.618	1.3880
8		10.423	33.122	56.455	1.4082
9		11.832	36.433	51.735	1.4127
10		15.012	43.964	41.024	1.4194
11	p	17.500	58.500	24.000	-
1	90+10	00.000	95.639	04.368	1.3650
2		24.869	72.258	02.872	1.3900
3		44.985	50.678	04.337	1.4135
4		59.937	37.886	03.677	1.4340
5		80.261	16.216	03.523	1.4600
6		97.295	00.000	02.701	1.4837
7		00.000	03.100	96.900	1.4108
8		14.376	03.636	71.368	1.4190
9		30.132	13.819	56.049	1.4318
10		36.771	12.722	50.507	1.4335
11		51.300	12.500	36.250	1.4378
12		67.100	00.000	32.900	1.4408
1	80+20	00.000	94.572	05.428	1.3650
2		23.300	72.100	04.600	1.3910
3		34.462	62.133	04.605	1.4040
4		51.500	47.000	01.500	1.4230
5		65.000	33.000	02.000	1.4410
6		82.200	16.200	03.600	1.4620
7		00.000	03.109	96.891	1.4120
8		14.807	03.409	81.784	1.4265
9		26.085	02.276	71.639	1.4320
10		33.328	04.343	62.325	1.4380
11		42.731	00.000	57.269	1.4440

Table- - 4

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 20°C

Sr.No.	%Dmf+W	$\%X_T$	$\%X_H$	$\%X_{Dmf+W}$	R.I.
1	100+0	00.000	94.850	05.149	1.3781
2		16.208	74.519	09.272	1.3950
3		22.917	70.069	07.014	1.4100
4		17.721	67.741	14.536	1.3991
5		16.547	75.907	07.546	1.3940
6		12.876	78.935	08.189	1.3918
7		11.546	79.632	08.822	1.3900
8		00.000	12.984	87.016	1.4270
9		10.057	13.097	76.846	1.4289
10		12.941	17.845	69.214	1.4299
11		18.566	34.155	47.279	1.4300
12	P	25.000	50.000	25.000	-
1	90+10	00.000	91.575	08.415	1.4209
2		12.100	78.100	09.800	1.4210
3		38.581	52.300	09.119	1.4240
4		42.100	48.200	09.700	1.4285
5		62.500	31.500	06.000	1.4480
6		81.429	16.332	02.239	1.4704
7		99.137	00.000	00.863	1.4930
8		00.000	03.126	96.874	1.4232
9		18.500	79.100	02.400	1.4365
10		30.100	68.000	01.900	1.4450
11		42.200	56.900	00.900	1.4530
12		56.094	00.000	43.906	1.4621
1	80+20	00.000	95.379	04.628	1.4135
2		12.300	82.500	05.200	1.4140
3		44.164	52.329	03.507	1.4200
4		61.700	34.500	03.800	1.4380
5		80.798	16.978	02.224	1.4645
6		99.177	00.000	00.823	1.4902
7		00.000	01.688	98.312	1.4200
8		17.200	01.300	81.500	1.4340
9		28.517	00.000	71.483	1.4432

Table- - 5

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 30°C

Sr.No.	%Dmf+W	$\%X_T$	$\%X_H$	$\%X_{Dmf+W}$	R.I.
1	100+0	00.000	90.100	09.900	1.3735
2		06.790	81.910	11.300	1.3800
3		08.620	79.294	12.086	1.3820
4		14.837	70.157	15.006	1.3880
5		20.326	53.790	25.884	1.3981
6		20.656	43.482	35.862	1.4010
7		00.000	12.909	87.091	1.4155
8		01.600	16.081	82.319	1.4180
9		03.039	19.500	77.411	1.4200
10		07.104	17.424	75.472	1.4213
11		14.891	21.895	63.214	1.4240
12		18.795	27.764	53.441	1.4265
13	P	21.000	44.000	35.000	-
1	90+10	00.000	97.068	02.932	1.3765
2		22.745	69.917	07.338	1.4026
3		44.100	48.270	07.630	1.4220
4		55.660	35.147	09.193	1.4410
5		82.682	15.839	01.479	1.4670
6		99.021	00.000	00.797	1.4856
7		00.000	04.144	95.856	1.4189
8		15.648	08.300	76.052	1.4329
9		17.531	04.759	77.710	1.4305
10		36.100	02.200	41.700	1.4450
11		56.714	00.000	43.286	1.4570
12					
1	80+20	00.000	98.007	01.993	1.3780
2		23.143	70.936	05.921	1.4008
3		45.008	51.733	03.259	1.4252
4		63.225	33.320	02.655	1.4536
5		81.826	15.675	01.499	1.4680
6		99.465	00.000	00.535	1.4900
7		00.000	01.015	98.985	1.4121
8		07.900	01.100	91.000	1.4135
9		11.195	00.697	88.208	1.4145
10		15.215	00.000	84.785	1.4190

Table- - 6

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+W	$\%X_T$	$\%X_H$	$\%X_{Dmf+W}$	R.I.
1	100+0	00.000	41.063	58.936	1.3700
2		12.297	56.591	31.112	1.3890
3		10.832	66.406	22.762	1.3860
4		09.780	67.509	22.711	1.3855
5		12.942	45.862	41.196	1.3910
6		14.381	55.101	30.518	1.3950
7		15.118	60.821	24.061	1.3935
8		00.000	15.287	84.713	1.4138
9		08.354	25.618	66.028	1.4250
10		14.254	25.239	60.507	1.4300
11		22.150	10.662	67.186	1.4490
12		39.154	07.891	52.954	1.4620
13	p	15.500	50.000	34.500	-
1	90+10	00.939	90.755	08.305	1.4159
2		09.500	80.500	10.000	1.4160
3		28.000	60.500	11.500	1.4210
4		43.049	42.426	14.524	1.4270
5		63.000	27.500	09.500	1.4460
6		82.753	15.160	02.077	1.4702
7		00.000	04.252	95.748	1.4185
8		07.000	03.400	89.600	1.4235
9		28.000	04.000	68.000	1.4350
10		47.000	02.000	51.000	1.4490
11		61.136	00.000	38.864	1.4611
1	80+20	00.000	95.631	04.369	1.3689
2		17.100	73.100	09.860	1.3820
3		46.495	49.694	03.353	1.4170
4		65.000	31.500	03.500	1.4390
5		81.500	16.000	02.500	1.4560
6		98.388	00.000	01.611	1.4730
7		00.000	02.297	97.703	1.4136
8		11.200	02.300	86.500	1.4180
9		18.000	02.000	80.000	1.4230
10		32.921	00.000	67.079	1.4393

Table- - 7

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(w) at 20°C

Sr.No.	%Dmf+W	%X_X	%X_H	%X_{Dmf+W}	R.I.
1	100+0	00.000	97.950	02.050	1.3780
2		19.392	74.318	06.370	1.3952
3		22.961	70.711	06.318	1.4011
4		17.125	79.106	03.769	1.3935
5		13.550	83.460	02.980	1.3878
6		12.100	83.893	03.997	1.3846
7		00.000	12.275	87.725	1.4224
8		08.360	14.920	76.720	1.4265
9		11.320	13.940	74.740	1.4277
10		28.500	46.500	26.000	1.4300
11		14.750	17.000	68.250	1.4279
12		28.000	37.000	35.000	1.4290
13		27.000	57.000	16.000	1.4280
14	P	28.500	46.000	25.500	-
1	90+10	00.000	94.576	05.424	1.3753
2		14.000	76.000	10.000	1.3930
3		38.768	46.242	14.990	1.4281
4		57.000	34.000	13.000	1.4460
5		81.520	16.452	02.023	1.4732
6		98.708	00.000	01.291	1.4931
7		00.000	04.000	96.000	1.4234
8		09.000	04.000	86.000	1.4320
9		23.000	04.000	73.000	1.4480
10		36.000	02.000	62.000	1.4610
11		47.476	00.000	52.523	1.4730
1	80+20	00.000	95.868	04.131	1.3752
2		44.260	52.792	02.947	1.4279
3		76.462	22.063	01.473	1.4650
4		98.913	00.000	01.086	1.4922
5		00.000	01.345	98.654	1.4202
6		02.500	01.500	96.000	1.4220
7		06.500	01.000	92.500	1.4248
8		11.167	00.000	88.832	1.4282

Table- - 8

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(w):- at 30°C

Sr.No.	%Dmf+W	%X_X	%X_H	%X_{Dmf+W}	R . I .
1	100+0	00.000	95.880	04.111	1.3741
2		18.710	72.020	09.260	1.3990
3		22.670	69.830	21.880	1.4091
4		16.960	78.360	04.660	1.3926
5		13.350	82.230	04.400	1.3884
6		11.940	82.790	05.250	1.3861
7		00.000	12.940	87.050	1.4210
8		08.240	16.000	75.750	1.4230
9		11.140	15.210	74.080	1.4282
10		16.970	22.590	60.420	1.4314
11		24.000	61.000	15.000	1.4323
12		22.100	32.100	45.800	1.4321
13	P	26.000	45.000	29.000	-
1	90+10	00.000	94.013	05.986	1.3720
2		37.557	54.839	07.602	1.4230
3		78.978	15.947	05.074	1.4711
4		93.554	00.000	06.445	1.4871
5		00.000	06.970	93.029	1.4211
6		10.000	04.000	86.000	1.4300
7		27.000	04.000	69.000	1.4450
8		48.862	00.000	51.132	1.4675
1	80+20	00.000	90.848	09.151	1.3726
2		42.687	50.949	06.363	1.4300
3		75.405	21.747	02.847	1.4661
4		98.268	00.000	01.731	1.4875
5		00.000	02.757	97.242	1.4167
6		06.000	01.000	93.000	1.4200
7		14.575	00.000	85.424	1.4270

Table- - 9

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+W	%Xx	%X_H	%X_{Dmf+W}	R.I.
1	100+0	00.000	95.890	04.075	1.3714
2		22.120	68.130	09.730	1.4074
3		16.800	77.640	05.540	1.3910
4		13.150	81.040	05.790	1.3861
5		11.790	81.710	06.484	1.3820
6		00.000	14.240	85.750	1.4150
7		08.180	16.630	75.180	1.4159
8		10.780	17.870	71.330	1.4206
9		14.408	20.702	65.196	1.4271
10		19.000	29.000	52.000	1.4300
11		23.000	41.000	36.000	1.4350
12	P	24.000	54.000	22.000	-
1	90+10	00.000	92.463	07.536	1.3681
2		17.200	75.000	07.800	1.3910
3		35.100	59.100	05.800	1.4215
4		67.286	13.586	03.558	1.4666
5		80.100	16.100	03.800	1.4770
6		96.878	00.000	03.121	1.4830
7		00.000	08.526	91.473	1.4180
8		10.000	08.100	81.900	1.4250
9		34.900	03.000	62.100	1.4460
10		49.321	00.000	50.678	1.4590
1	80+20	00.000	92.861	07.133	1.3684
2		25.100	68.700	06.200	1.4070
3		43.242	16.550	05.125	1.4287
4		75.352	21.728	02.914	1.4622
5		97.887	00.000	02.137	1.4816
6		00.000	04.865	98.340	1.4139
7		06.200	03.100	90.700	1.4145
8		15.820	00.000	84.674	1.4241

Table- - 10

Mutual solubility data for the Quaternary System

Benzene(B)-Hept (H')-Dmf(D) + Water(w) at 20°C

Sr.No.	%Dmf+W	%X_B	%$X_{H'}$	%X_{Dmf+W}	R.I.
1	100+0	00.000	95.861	04.138	1.3998
2		11.915	68.755	19.329	1.4110
3		14.710	64.930	20.360	1.4160
4		14.509	47.842	37.647	1.4230
5		00.000	16.005	83.994	1.4260
6		10.164	23.876	65.958	1.4300
7		15.859	32.683	51.456	1.4268
8		05.755	19.462	74.781	1.4271
9		13.238	29.467	57.293	1.4321
10	P	16.500	43.000	40.500	-
1	90+10	00.000	98.572	01.427	1.3965
2		44.179	54.628	01.191	1.4365
3		63.646	34.977	01.376	1.4580
4		82.451	16.992	00.556	1.4790
5		99.361	00.000	00.638	1.4980
6		00.000	04.343	95.656	1.4272
7		24.704	08.140	67.149	1.4440
8		37.201	07.600	55.199	1.4486
9		56.098	05.780	38.120	1.4630
10		62.663	01.094	36.241	1.4726
1	80+20	00.000	98.830	01.169	1.4030
2		22.978	75.768	01.253	1.4200
3		47.500	51.250	01.250	1.4412
4		63.781	35.054	01.159	1.4570
5		81.100	12.100	00.800	1.4769
6		99.463	00.000	00.536	1.4987
7		00.000	00.747	99.252	1.4221
8		11.300	06.200	86.500	1.4280
9		21.100	01.000	77.900	1.4400
10		33.038	00.000	66.961	1.4431

Table- - 11

Mutual solubility data for the Quaternary System

Benzene(B)-Hept (H')-Dmf(D) + Water(w) at 30°C

Sr.No.	%Dmf+W	$\%X_B$	$\%X_{H'}$	$\%X_{Dmf+W}$	R.I.
1	100+0	10.367	60.590	29.041	1.4032
2		12.292	65.990	22.710	1.4130
3		14.087	58.062	28.335	1.4135
4		13.672	45.079	41.249	1.4248
5		00.000	17.934	82.065	1.4149
6		08.943	23.585	67.470	1.4224
7		11.140	46.834	42.024	1.4250
8		04.786	22.909	72.304	1.4290
9		10.718	35.354	53.926	1.4290
10	P	15.000	45.000	40.000	-
1	90+10	00.000	97.647	02.352	1.3991
2		21.936	72.333	05.729	1.4163
3		43.446	53.722	02.830	1.4324
4		63.268	34.769	01.961	1.4523
5		81.100	16.800	02.100	1.4730
6		97.986	00.000	01.946	1.4928
7		00.000	04.168	95.831	1.4221
8		20.386	15.313	64.300	1.4397
9		33.965	12.470	53.564	1.4440
10		44.717	08.267	47.014	1.4515
11		50.707	09.308	39.983	1.4588
12		66.460	00.000	33.539	1.4726
1	80+20	00.000	97.953	02.046	1.3995
2		23.623	74.898	02.386	1.4157
3		44.045	54.462	01.491	1.4339
4		63.360	34.820	01.818	1.4560
5		81.754	16.860	01.385	1.4747
6		98.786	00.000	01.213	1.4929
7		00.000	01.316	98.683	1.4168
8		12.541	08.998	78.459	1.4261
9		23.816	01.689	74.494	1.4349
10		31.840	01.700	66.395	1.4425
11		38.401	00.000	61.598	1.4483

Table- - 12

Mutual solubility data for the Quaternary System

Benzene(B)-Hept (H')-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+W	$\%X_B$	$\%X_{H'}$	$\%X_{Dmf+W}$	R.I.
1	100+0	00.000	92.824	07.175	1.3960
2		11.763	67.882	20.353	1.4089
3		12.271	50.577	37.151	1.4190
4		09.715	69.271	21.013	1.4070
5		00.000	18.605	81.394	1.4183
6		07.237	25.547	67.165	1.4211
7		09.639	27.810	62.549	1.4200
8		11.474	26.478	62.047	1.4190
9	P	13.500	54.000	32.500	-
1	90+10	00.000	97.314	02.685	1.3940
2		21.238	70.043	08.718	1.4109
3		43.041	53.232	03.726	1.4289
4		62.482	34.344	03.173	1.4480
5		79.082	16.280	04.637	1.4670
6		95.341	00.000	04.658	1.4875
7		00.000	07.437	92.562	1.4200
8		23.761	11.644	64.594	1.4343
9		38.558	04.834	56.606	1.4387
10		46.474	11.418	42.107	1.4485
11		53.129	10.775	36.095	1.4527
12		58.914	07.013	34.072	1.4572
13		67.100	00.000	32.900	1.4408
1	80+20	00.000	97.435	02.564	1.4092
2		42.885	53.040	04.074	1.4300
3		63.062	34.656	02.280	1.4470
4		81.268	16.748	01.982	1.4660
5		96.874	00.000	03.125	1.4860
6		00.000	04.343	95.656	1.4130
7		13.543	02.457	84.000	1.4190
8		26.171	02.684	71.138	1.4321
9		43.583	00.000	56.416	1.4426

Table- - 13

Mutual solubility data for the Quaternary System

Benzene(B)-Oct (O)-Dmf(D) + Water(w) at 20°C

Sr.No.	%Dmf+W	%X_B	%Xo	%X_{Dmf+W}	R.I.
1	100+0	00.000	98.650	01.350	1.3875
2		14.790	81.990	03.210	1.3972
3		19.530	77.290	03.180	1.4045
4		31.000	63.000	06.000	1.4195
5		23.100	73.140	03.760	1.4081
6		34.000	55.000	11.000	1.4245
7		00.000	04.640	95.360	1.4241
8		11.930	10.380	77.690	1.4300
9		19.700	14.030	66.270	1.4358
10		28.000	21.000	51.000	1.4425
11		36.000	42.000	22.000	1.4600
12	P	34.000	30.000	36.000	-
1	90+10	00.000	98.770	01.230	1.3892
2		10.000	88.800	01.210	1.4028
3		25.000	74.000	01.000	1.4190
4		40.000	59.100	00.900	1.4347
5		55.000	44.200	00.810	1.4510
6		70.000	293.000	00.700	1.4670
7		85.000	14.300	00.700	1.4835
8		99.350	00.000	00.650	1.4980
9		00.000	02.130	97.870	1.4230
10		10.010	03.750	86.240	1.4300
11		20.000	05.000	75.000	1.4370
12		30.020	04.500	65.480	1.4440
13		40.100	04.010	55.890	1.4520
14		50.000	03.100	46.900	1.4590
15		65.360	00.000	34.640	1.4700
1	80+20	00.000	98.910	01.090	1.3893
2		12.300	86.650	01.050	1.4020
3		29.100	69.860	01.040	1.4210
4		51.200	47.790	01.010	1.4450
5		70.500	28.500	01.000	1.4660
6		90.400	08.640	00.960	1.4880
7		99.540	00.000	00.006	1.4987
8		00.000	00.004	99.560	1.4175
9		10.200	00.800	89.000	1.4250
10		20.100	00.900	79.000	1.4320
11		32.950	00.000	67.050	1.4430

Table- - 14

Mutual solubility data for the Quaternary System

Benzene(B)-Oct (O)-Dmf(D) + Water(w) at 30°C

Sr.No.	%Dmf+W	%X_B	%Xo	%X_{Dmf+W}	R . I .
1	100+0	00.000	97.980	02.020	1.3854
2		14.560	80.690	04.740	1.3967
3		19.330	76.480	04.190	1.4021
4		22.820	72.230	04.950	1.4061
5		32.100	59.800	08.100	1.4150
6		00.000	06.440	93.560	1.4231
7		11.680	12.170	76.140	1.4280
8		19.370	15.440	65.180	1.4325
9		30.100	25.000	44.900	1.4430
10	P	32.200	42.500	25.300	-
1	90+10	00.000	98.640	01.360	1.3866
2		17.500	81.020	01.480	1.4060
3		40.500	57.900	01.600	1.4300
4		65.000	33.250	01.750	1.4560
5		97.986	00.000	01.946	1.4928
6		00.000	02.930	97.070	1.4212
7		10.500	06.200	83.300	1.4290
8		25.300	08.100	67.700	1.4400
9		40.100	07.200	52.700	1.4520
10		55.200	04.300	40.500	1.4644
11		66.460	00.000	33.539	1.4726
1	80+20	00.000	98.770	01.230	1.3865
2		17.100	81.700	01.200	1.4040
3		37.050	61.770	01.180	1.4250
4		62.010	36.990	01.000	1.4515
5		87.000	12.100	00.900	1.4770
6		99.000	00.000	00.865	1.4903
7		00.000	01.040	98.960	1.4159
8		07.000	02.500	90.500	1.4210
9		16.500	03.100	80.400	1.4290
10		27.500	03.000	69.500	1.4380
11		39.401	00.000	61.598	1.4483

Table- - 15

Mutual solubility data for the Quaternary System

Benzene(B)-Oct (O)-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+W	%X_B	%X_O	%X_{Dmf+W}	R.I.
1	100+0	00.000	97.290	02.710	1.3833
2		14.440	80.040	05.520	1.3939
3		19.110	75.660	05.230	1.4000
4		22.510	71.260	06.230	1.4010
5		29.100	60.020	10.880	1.4140
6		01.580	06.930	91.440	1.4189
7		11.560	13.050	75.390	1.4240
8		19.120	16.510	64.370	1.4270
9		30.050	36.100	33.850	1.4305
10	P	31.000	45.000	24.000	-
1	90+10	00.000	97.920	02.080	1.3826
2		13.300	82.690	04.010	1.4010
3		37.100	57.000	05.900	1.4281
4		67.500	26.400	06.100	1.4632
5		95.340	00.000	04.650	1.4875
6		00.000	03.720	96.280	1.4179
7		12.010	05.050	82.940	1.4220
8		26.020	09.100	64.880	1.4285
9		50.100	08.020	41.880	1.4341
10		67.100	00.000	32.900	1.4408
1	80+20	00.000	98.040	01.960	1.3828
2		22.500	74.480	03.020	1.4090
3		48.100	47.790	04.110	1.4350
4		78.500	17.470	04.030	1.4667
5		96.870	00.000	03.120	1.4860
6		00.000	01.850	98.150	1.4120
7		11.500	04.020	84.480	1.4190
8		23.040	04.050	72.910	1.4270
9		42.730	00.000	57.269	1.4440

Table- - 16

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmso(D') + Water(W) at 20°C

Sr.No.	%Dmso+W	$\%X_B$	$\%X_H$	$\%X_{Dmso+W}$	R.I.
1	100+0	00.000	97.436	02.564	1.3777
2		24.371	73.815	01.814	1.4028
3		46.020	52.267	01.713	1.4380
4		52.100	44.000	03.900	1.4545
5		00.000	01.877	98.123	1.4780
6		06.200	03.900	90.900	1.4798
7		35.100	07.000	57.900	1.4888
8		47.300	08.900	43.800	1.4926
9	P	50.500	16.000	33.500	-
1	90+10	00.000	98.710	01.284	1.3800
2		24.524	74.269	01.207	1.4039
3		46.020	52.267	01.713	1.4283
4		61.378	30.982	07.640	1.4629
5		80.314	15.202	04.484	1.4819
6		95.956	00.000	04.044	1.5030
7		00.000	00.962	99.038	1.4668
8		21.100	00.900	78.000	1.4693
9		41.500	00.500	58.000	1.4716
10		49.054	00.000	50.946	1.4725
1	80+20	00.000	99.042	00.958	1.3825
2		24.670	74.737	00.593	1.4029
3		46.032	52.281	01.687	1.4040
4		51.292	25.891	02.000	1.4539
5		99.522	00.000	00.478	1.5037
6		00.000	00.479	99.521	1.4518
7		04.900	00.100	95.000	1.4533
8		09.373	00.000	90.627	1.4547

Table- - 17

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmso(D') + Water(W) at 30°C

Sr.No.	%Dmso+W	%X_B	%X_H	%X_{Dmso+W}	R.I.
1	100+0	00.000	99.500	00.500	1.3010
2		27.803	68.083	04.114	1.3187
3		44.000	54.000	03.000	1.4150
4		51.363	39.917	08.720	1.4472
5		00.000	03.929	96.071	1.4675
6		26.203	07.912	65.907	1.4584
7		27.091	08.180	64.729	1.4610
8		31.803	09.160	59.047	1.4615
9		38.547	19.451	42.002	1.4640
10		39.067	11.818	49.125	1.4596
11	P	45.148	26.164	28.688	-
1	90+10	12.300	86.800	01.900	1.3520
2		27.500	71.050	01.450	1.3760
3		44.700	54.100	01.200	1.4200
4		69.100	29.200	01.700	1.4460
5		98.530	00.000	01.470	1.4492
6		11.100	00.100	88.800	1.4543
7		31.300	01.080	67.620	1.4572
8		37.100	01.170	61.730	1.4621
9		44.515	00.000	55.485	1.4729
1		00.000	98.500	01.500	1.3542
2		12.000	87.000	01.000	1.3820
3	80+20	44.200	54.000	01.800	1.4440
4		69.000	29.000	01.000	1.4640
5		96.820	00.000	03.180	1.4780
6		00.000	01.210	98.788	1.4425
7		04.096	00.266	95.138	1.4452
8		10.187	00.000	89.813	1.4492

Table- - 18

Mutual solubility data for the Quaternary System

Benzene (B)- Hexane (H)-Dmso(D') + Water(W) at 40°C

Sr.No.	%Dmso+W	%X_B	%X_H	%X_{Dmso+W}	R.I.
1	100+0	00.000	93.081	06.918	1.4579
2		26.651	70.568	02.779	1.3855
3		49.509	45.968	04.521	1.4210
4		38.924	13.855	47.219	1.4708
5		00.000	02.860	97.139	1.4669
6		26.779	05.872	67.348	1.4715
7		35.015	11.055	53.929	1.4734
8	P	38.090	12.010	49.899	-
1	90+10	00.000	99.351	00.654	1.3645
2		24.646	74.589	00.766	1.3930
3		46.434	52.698	00.866	1.4245
4		65.265	33.253	00.819	1.4510
5		83.319	15.772	00.909	1.4808
6		97.900	00.000	02.100	1.4879
7		00.000	02.372	97.642	1.4540
8		13.690	01.035	85.279	1.4560
9		30.744	05.425	63.831	1.4578
10		44.379	00.336	55.273	1.4665
1	80+20	00.000	99.000	03.800	1.3703
2		24.575	74.368	01.057	1.3950
3		46.320	52.608	01.064	1.4186
4		65.686	33.257	00.807	1.4460
5		83.549	15.815	00.636	1.4720
6		99.508	00.000	00.491	1.4920
7		00.000	01.210	98.788	1.4425
8		04.100	00.700	95.200	1.4460
9		08.853	00.000	91.147	1.4470

Table- - 19

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(w) at 20°C

Sr.No.	%Dmso+W	%X_T	%X_H	%X_{Dmso+W}	R.I.
1	100+0	00.000	98.027	01.973	1.3800
2		44.432	52.753	02.815	1.4342
3		32.000	65.700	02.300	1.4180
4		52.900	45.000	02.100	1.4470
5		56.319	21.447	22.233	1.4562
6		58.851	22.411	18.738	1.4730
7		00.000	03.847	96.153	1.4792
8		15.772	05.362	78.866	1.4794
9		26.666	06.666	66.668	1.4796
10		34.244	08.675	57.081	1.4802
11		37.109	10.156	52.735	1.4822
12		39.848	07.633	52.519	1.4840
13		44.348	08.544	47.058	1.4852
14	P	53257	06.751	39.992	1.4860
1	90+10	00.000	97.772	02.228	1.3778
2		24.410	74.368	01.220	1.4072
3		43.711	50.241	06.048	1.4310
4		61.209	31.079	07.712	1.4475
5		83.051	15.911	01.038	1.4739
6		99.009	00.000	00.991	1.4942
7		00.000	00.239	99.771	1.4575
8		10.100	00.100	89.800	1.4650
9		20.232	00.000	79.768	1.4720
1	80+20	00.000	98.415	01.585	1.3801
2		24.564	74.837	00.599	1.4071
3		45.466	52.261	02.273	1.4395
4		65.529	33.131	01.340	1.4510
5		82.853	15.871	01.028	1.4720
6		99.262	00.000	00.738	1.4935
7		00.000	00.749	99.251	1.4530
8		02.200	00.300	97.500	1.4537
9		05.298	00.000	94.702	1.4545

Table- - 20

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(w) at 30°C

Sr.No.	%Dmso+W	$\%X_T$	$\%X_H$	$\%X_{Dmso+W}$	R.I.
1	100+0	00.000	98.679	01.321	1.3912
2	30 0C	22.449	75.699	01.854	1.4112
3		44.675	50.650	04.675	1.4322
4		47.654	20.800	31.548	1.4689
5		00.000	06.727	93.273	1.4695
6		13.050	03.846	83.104	1.4715
7		23.230	02.800	73.970	1.4699
8		30.267	05.484	64.249	1.4709
9		34.546	10.454	55.000	1.4703
10		37.139	11.444	51.417	1.4705
	P	47.654	20.800	31.548	
1	90+10	00.000	99.025	00.975	1.3680
2		22.679	76.478	00.843	1.3940
3		45.672	51.779	02.549	1.4210
4		63.689	32.090	04.221	1.4410
5		83.032	15.689	01.279	1.4631
6		99.862	00.000	00.138	1.4850
7		00.000	01.600	98.400	1.4545
8		05.801	02.010	92.189	1.4572
9		11.100	00.850	88.050	1.4600
10		17.845	00.000	82.155	1.4631
1	80+20	00.000	98.396	01.604	1.3686
2		22.648	76.375	00.977	1.3935
3		46.199	52.377	01.423	1.4275
4		65.598	33.055	01.347	1.4385
5		83.566	15.791	00.643	1.4600
6		99.266	00.000	00.734	1.4840
7		00.000	01.220	98.880	1.4449
8		01.100	00.500	98.400	1.4455
9		02.537	00.000	97.463	1.4459

Table- - 21

Mutual solubility data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(w) at 40°C

Sr.No.	%Dmso+W	$\%X_T$	$\%X_H$	$\%X_{Dmso+W}$	R . I .
1	100+0	00.500	98.389	01.618	1.3671
2		37.475	60.619	01.906	1.4075
3		51.652	41.099	07.249	1.4329
4		49.712	20.101	30.188	1.4637
5		21.163	06.193	76.876	1.4712
6		00.000	03.477	96.522	1.4665
7		30.058	07.090	62.022	1.4710
8	P	41.412	15.305	43.989	1.4700
1	90+10	00.000	98.387	01.613	1.3700
2		23.869	73.424	02.707	1.3952
3		43.834	50.629	05.537	1.4208
4		61.129	31.388	07.483	1.4423
5		81.300	15.719	02.580	1.4648
6		97.789	00.000	02.218	1.4850
7		00.000	01.185	98.815	1.4588
8		12.100	01.800	86.100	1.4611
9		24.895	00.000	75.105	1.4635
1	80+20	00.000	99.994	00.006	1.3669
2		23.386	71.937	04.670	1.3958
3		44.348	51.218	04.434	1.4191
4		58.120	36.075	05.805	1.4401
5		82.352	15.843	01.805	1.4649
6		98.051	00.000	01.949	1.4840
7		00.000	00.959	99.041	1.4352
8		03.300	00.440	96.260	1.4440
9		07.251	00.000	92.749	1.4515

Table- - 22

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 20°C

Sr.No.	%Dmso+W	$\%X_X$	$\%X_H$	$\%X_{Dmso+W}$	R.I.
1	100+0	00.000	99.019	00.981	1.3740
2		24.139	74.339	01.522	1.4020
3		44.699	53.317	01.984	1.4288
4		67.049	30.106	02.845	1.4570
5		70.585	27.169	02.246	1.4608
6		96.072	00.000	03.928	1.4901
7		00.000	01.757	98.243	1.4740
8		22.973	02.100	77.927	1.4768
9		34.728	02.103	63.167	1.4791
10		63.240	02.079	34.680	1.4863
11		75.026	01.408	23.564	1.4910
1	90+10	00.000	98.712	01.288	1.3837
2		30.000	67.000	03.000	1.4150
3		42.500	53.000	04.500	1.4330
4		62.588	32.124	05.288	1.4600
5		98.256	00.000	01.744	1.4910
6		00.000	00.948	99.052	1.4607
7		02.000	00.750	97.250	1.4620
8		03.250	00.500	96.250	1.4630
9		04.503	00.000	95.497	1.4640
1	80+20	00.000	99.038	00.962	1.3740
2		25.000	72.600	02.400	1.4100
3		41.500	56.000	02.500	1.4300
4		64.319	33.007	02.674	1.4541
5		76.000	21.500	02.500	1.4700
6		98.777	00.000	01.223	1.4921
7		00.000	00.616	99.384	1.4500
8		01.000	00.500	98.500	1.4503
9		02.000	00.250	97.750	1.4505
10		03.079	00.000	96.921	1.4508

Table- - 23

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 30°C

Sr.No.	%Dmso+W	%X_X	%X_H	%X_{Dmso+W}	R.I.
1	100+0	00.000	97.199	02.800	1.3738
2		23.920	73.748	02.330	1.4010
3		44.216	52.753	03.030	1.4280
4		66.100	29.678	04.221	1.4528
5		95.836	00.000	04.164	1.4905
6		00.000	02.006	97.994	1.4723
7		22.873	03.898	73.229	1.4766
8		34.480	04.786	60.734	1.4771
9		45.548	05.880	48.572	1.4798
10	P	63.693	02.167	34.320	1.4845
1	90+10	00.000	97.457	02.543	1.3730
2		31.000	61.300	07.700	1.4100
3		59.683	30.618	09.699	1.4445
4		95.164	00.000	04.836	1.4901
5		00.000	01.247	98.753	1.4607
6		02.500	00.700	96.800	1.4611
7		05.033	00.000	94.967	1.4615
1	80+20	00.000	96.831	03.169	1.3735
2		37.000	57.500	05.500	1.4200
3		62.308	31.975	05.717	1.4536
4		98.483	00.000	01.511	1.4901
5		00.000	01.068	98.932	1.4470
6		01.500	00.600	97.900	1.4474
7		03.381	00.000	96.619	1.4480

Table- - 24

Mutual solubility data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 40°C

Sr.No.	%Dmso+W	%X_X	%X_H	%X_{Dmso+W}	R.I.
1	100+0	00.000	98.526	01.474	1.3700
2		23.614	72.942	03.442	1.4330
3		43.585	52.022	04.393	1.4410
4		65.177	29.265	05.558	1.4510
5		70.423	27.109	02.468	1.4520
6		95.599	00.000	04.401	1.4870
7		00.000	02.027	97.973	1.4661
8		21.093	04.267	74.639	1.4710
9		34.218	03.546	62.235	1.4690
10		45.258	06.474	48.268	1.4731
11		51.245	07.776	40.977	1.4732
12	P	63.153	02.213	34.634	1.4772
13		74.922	01.546	23.539	1.4810
1	90+10	00.000	96.827	03.173	1.4210
2		30.100	59.800	10.100	1.4410
3		59.122	30.359	10.519	1.4596
4		78.200	13.300	08.500	1.4717
5		94.823	00.000	05.177	1.4838
6		00.000	01.837	98.163	1.4569
7		02.100	01.700	96.200	1.4572
8		05.858	00.000	94.142	1.4577
1	80+20	00.000	91.172	08.828	1.4331
2		33.100	56.700	10.200	1.4420
3		60.416	31.004	08.580	1.4544
4		80.100	13.700	06.200	1.4670
5		98.175	00.000	01.825	1.4838
6		00.000	02.651	97.349	1.4425
7		01.700	01.450	96.850	1.4428
8		03.984	00.000	96.010	1.4431

Table- - 25

Mutual solubility data for the Quaternary System

Benzene(B)-Hept(H')-Dmso(D') + Water(w) at 20°C

Sr.No.	%Dmso+W	%X_B	%$X_{H'}$	%X_{Dmso+W}	R.I.
1	100+0	00.000	98.000	02.000	1.4100
2		22.680	75.030	02.290	1.4139
3		42.930	53.280	03.790	1.4308
4		54.550	30.800	15.370	1.4670
5		24.330	05.030	70.640	1.4470
6		00.000	01.800	98.200	1.4606
7		41.000	07.200	52.700	1.4801
8	P	44.500	11.500	44.000	1.4816
1	90+10	00.000	99.200	00.880	1.4005
2		29.500	66.900	03.600	1.4275
3		61.026	33.653	05.319	1.4529
4		77.000	18.100	04.900	1.4750
5		98.700	00.000	01.300	1.4940
6		00.000	00.790	99.210	1.4631
7		14.100	00.500	85.400	1.4650
8		35.000	00.200	64.800	1.4700
9		44.800	00.000	55.200	1.4782
1	80+20	00.000	99.410	00.581	1.4001
2		34.000	63.700	02.300	1.4350
3		62.792	34.627	02.581	1.4518
4		75.100	21.100	03.800	1.4770
5		91.100	07.500	02.400	1.4930
6		99.522	00.000	00.478	1.5037
7		00.000	00.400	99.600	1.4480
8		02.850	00.300	96.850	1.4500
9		05.600	00.150	94.250	1.4520
10		08.400	00.050	91.550	1.4540
11		09.373	00.000	90.626	1.4547

Table- - 26

Mutual solubility data for the Quaternary System

Benzene(B)-Hept(H')-Dmso(D') + Water(w) at 30°C

Sr.No.	%Dmso+W	%X_B	%$X_{H'}$	%X_{Dmso+W}	R.I.
1	100+0	00.000	97.400	02.600	1.4100
2		22.500	74.610	02.840	1.4135
3		42.700	52.980	04.320	1.4311
4		53.760	29.650	16.590	1.4699
5		60.000	04.660	35.340	1.4705
6		11.100	05.010	85.890	1.4570
7		18.500	04.650	76.850	1.4700
8		30.500	05.700	63.800	1.4750
9	P	42.300	12.100	35.600	1.4770
1	90+10	00.000	95.660	04.340	1.3960
2		25.050	71.230	03.820	1.4200
3		55.500	41.500	03.000	1.4518
4		76.500	21.200	02.300	1.4000
5		98.530	00.000	01.470	1.4903
6		00.000	01.010	98.990	1.4601
7		20.600	00.500	78.900	1.4670
8		33.500	00.250	66.250	1.4700
9		44.515	00.000	55.466	1.4729
1	80+20	00.000	97.090	02.910	1.3986
2		28.500	69.100	02.400	1.4300
3		50.890	47.070	02.104	1.4540
4		74.000	24.400	01.600	1.4700
6		98.890	00.000	01.110	1.4925
7		00.000	00.610	99.390	1.4492
8		05.100	00.300	94.600	1.4515
9		10.330	00.000	89.670	1.4552

Table- - 27

Mutual solubility data for the Quaternary System

Benzene(B)-Hept(H')-Dmso(D') + Water(w) at 40°C

Sr.No.	%Dmso+W	%X_B	%$X_{H'}$	%X_{Dmso+W}	R.I.
1	100+0	00.000	90.000	10.000	1.4020
2		20.570	72.430	07.000	1.4126
3		41.720	51.800	06.480	1.4300
4		59.130	32.590	08.280	1.4548
5		00.000	07.740	92.260	1.4710
6		06.500	11.000	82.500	1.4720
7		51.600	31.000	17.400	1.4782
8	P	35.500	24.000	40.500	1.4750
1	90+10	00.000	96.300	03.700	1.3956
2		26.000	70.700	03.300	1.4200
3		54.350	42.640	03.010	1.4480
4		78.500	19.000	02.500	1.4700
5		97.900	00.000	02.100	1.4879
6		00.000	01.440	98.560	1.4590
7		21.000	00.920	78.080	1.4650
8		36.000	00.450	63.550	1.4700
9		52.490	00.000	47.051	1.4753
1	80+20	00.000	96.450	03.550	1.3940
2		32.200	62.500	02.600	1.4250
3		57.100	41.100	01.800	1.4500
4		77.100	21.700	01.200	1.4700
5		99.509	00.000	00.490	1.4920
6		00.000	01.010	98.990	1.4480
7		07.100	00.400	92.500	1.4560
8		08.853	00.000	91.147	1.4595
9		11.790	00.000	88.210	1.4651

Table- - 28

Mutual solubility data for the Quaternary System

Benzene(B)-Oct(O)-Dmso(D') + Water(w) at 20°C

Sr.No.	%Dmso+W	%X_B	%Xo	%X_{Dmso+W}	R.I.
1	100+0	00.000	99.300	00.700	1.3893
2		23.865	75.533	00.602	1.4041
3		45.398	53.816	00.856	1.4500
4		56.200	27.100	16.700	1.4950
5		00.000	01.226	98.774	1.4708
6		27.044	03.209	69.747	1.4727
7		36.822	05.092	58.086	1.4737
8	P	52.091	08.401	39.508	1.4750
9		54.736	22.234	23.020	1.4768
1	90+10	00.000	99.393	00.607	1.3891
2		35.000	64.000	00.500	1.4120
3		65.101	34.352	00.547	1.4465
4		73.500	21.000	01.100	4.4600
5		75.956	00.000	04.044	1.5030
6		00.000	00.125	99.875	1.4605
7		14.100	00.090	85.81	1.4635
8		26.500	00.060	64.440	1.4650
9		49.054	00.000	50.946	1.4725
1	80+20	00.000	99.537	00.463	1.3890
2		41.500	68.700	00.430	1.4200
3		65.190	34.390	00.420	1.4495
4		86.100	13.500	00.400	1.4800
5		99.529	00.000	00.478	1.5037
6		00.000	00.055	99.945	1.4490
7		06.000	00.250	97.750	1.4525
8		09.373	00.000	90.627	1.4547

Table- - 29

Mutual solubility data for the Quaternary System

Benzene(B)-Oct(O)-Dmso(D') + Water(w) at 30°C

Sr.No.	%Dmso+W	%X_B	%X_O	%X_{Dmso+W}	R.I.
1	100+0	00.000	99.397	00.603	1.3876
2		23.728	75.124	01.148	1.3926
3		44.974	53.394	01.632	1.4460
4		00.000	00.707	99.292	1.4080
5		23.292	03.220	73.486	1.4760
6		36.686	05.441	57.873	1.4779
7	P	40.964	10.628	39.408	1.4797
8		54.771	24.179	22.000	1.4850
1	90+10	00.000	98.198	01.802	1.3870
2		64.953	34.274	00.773	1.4390
3		14.100	84.770	01.130	1.4000
4		39.500	59.800	00.700	1.4200
5		98.530	00.000	01.470	1.4492
6		00.000	00.236	99.764	1.4591
7		19.000	01.110	80.890	1.4650
8		44.515	00.000	53.065	1.4729
1	80+20	00.000	98.764	01.236	1.3876
2		51.500	1800.000	00.500	1.4200
3		65.197	34.403	00.400	1.4345
4		81.500	17.900	00.600	1.4600
5		98.990	00.000	01.110	1.4925
6		00.000	00.554	99.945	1.4472
7		06.300	00.030	93.770	1.4510
8		10.330	00.000	89.670	1.4557

Table- - 30

Mutual solubility data for the Quaternary System

Benzene(B)-Oct(O)-Dmso(D') + Water(W) at 40°C

Sr.No.	%Dmso+W	%X_B	%Xo	%X_{Dmso+W}	R.I.
1	100+0	00.000	99.078	00.922	1.3806
2		23.652	74.877	01.471	1.3852
3		44.824	53.214	01.962	1.4403
4		50.900	47.000	02.100	1.4850
5		00.000	01.226	98.773	1.4647
6		23.186	03.659	73.155	1.4711
7		36.555	05.781	57.664	1.4731
8	P	45·10	7·6	47·30	1.4721
9		49.534	19.209	31.256	1.4688
1	90+10	00.000	97.529	02.471	1.3850
2		31.100	67.050	01.850	1.4000
3		64.760	34.150	01.069	1.4332
4		80.500	18.350	01.150	1.4600
5		97.900	00.000	02.100	1.4879
6		00.000	00.253	99.747	1.4450
7		15.500	00.110	84.390	1.4600
8		34.500	00.040	65.460	1.4650
9		52.490	00.000	47.510	1.4753
1	80+20	00.000	98.629	01.378	1.3820
2		32.500	66.500	01.000	1.4000
3		65.117	34.358	00.525	1.4291
4		80.500	19.220	00.380	1.4600
5		99.509	00.000	00.492	1.4920
6		00.000	00.187	99.813	1.4420
7		04.100	00.100	95.800	1.4450
8		11.790	00.000	88.210	1.4551

Table-31

Tie line data for the Quaternary System

Bemeze(B)- Hexane (H)-Dmf(D) + Water(w) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No.	%Dmf+Water	$R.I._E$	X_{BE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{HR}	X_{DR+WR}
1	100+0	1.4251	05.000	15.000	80.000	1.3765	02.500	92.500	05.000
2		1.4269	10.000	17.000	73.000	1.3825	05.000	87.000	05.000
3		1.4278	12.000	21.000	67.000	1.3860	10.000	85.000	05.000
4		1.4301	17.000	24.000	54.000	1.3881	12.700	81.000	06.300
5		1.4320	22.500	27.000	50.500	1.3971	17.000	73.000	10.000
6	90+10	1.4400	28.500	12.000	54.500	1.4567	70.000	29.000	01.000
7		1.4220	07.800	11.500	81.500	1.3995	24.500	73.000	02.500
8		1.4370	24.000	11.000	65.000	1.4470	62.500	35.500	02.000
9		1.4324	17.500	12.000	70.500	1.4220	44.000	53.750	02.250
10		1.4350	20.750	11.500	67.750	1.4350	53.250	44.750	02.000
11	80+20%	1.4204	02.700	01.200	96.100	1.3951	20.000	75.000	05.000
12		1.4231	06.700	01.500	91.800	1.4216	43.500	54.000	02.500
13		1.4260	11.500	01.500	87.000	1.4415	60.000	39.000	01.000
14		1.4367	29.000	01.500	69.500	1.4730	85.000	14.000	01.000
15		1.4310	20.250	01.500	78.250	1.4570	72.500	26.500	01.000

Table-32

Tie line data for the Quaternary System

Benzene(B)- Hexane (H)-Dmf(D) + Water(w) at 30°C

		Extract Phase				Reffinate Phase			
Sr.No.	%Dmf+Water	$R.I._E$	X_{BE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{HR}	X_{DR+WR}
1	100+0	1.4940	05.000	18.500	76.500	1.3750	01.500	92.500	07.000
2		1.4216	08.000	21.500	70.500	1.3760	04.200	86.000	09.800
3		1.4226	10.000	25.000	65.000	1.3795	08.000	80.000	12.000
4		1.4188	04.200	19.800	76.500	1.3780	01.500	79.000	19.200
5		1.4170	02.200	23.000	75.000	1.3745	01.000	85.500	13.500
6		1.4204	06.000	20.500	73.500	1.3755	04.000	61.960	33.980
7	90+10	1.4220	05.000	10.000	85.000	1.3985	26.500	69.000	04.500
8		1.4260	19.000	14.000	67.000	1.4236	46.700	49.000	04.300
9		1.4204	24.000	16.100	59.900	1.4497	69.700	27.300	03.000
10		1.4150	02.700	06.700	90.600	1.3780	13.500	85.000	01.500
11		1.4410	45.200	11.100	43.700	1.4500	75.300	22.400	02.300
12	80+20%	1.4167	03.000	01.250	95.750	1.3891	17.000	78.000	05.000
13		1.4192	07.750	01.000	91.250	1.4130	39.000	56.500	04.500
14		1.4195	08.750	00.750	90.500	1.4180	43.000	53.500	03.500
15		1.4251	20.500	00.500	79.000	1.4612	71.000	28.500	00.500
16		1.4221	14.620	00.500	84.870	1.4421	57.000	42.500	00.500

Table-33

Tie line data for the Quaternary System

Benzene(B)- Hexane (H)-Dmf(D) + Water(w) at 40°C

Sr.No.	%Dmf+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{BE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{HR}	X_{DR+WR}
1	100+0	1.4089	10.500	33.500	56.000	1.3750	05.200	87.500	07.300
2		1.4175	14.000	43.500	43.500	1.3845	12.500	75.000	12.500
3		1.4120	16.000	45.500	38.500	1.3860	13.000	70.000	17.000
4		1.4170	12.250	36.000	51.750	1.3781	08.800	82.000	09.150
5	90+10	1.4210	16.000	07.000	78.500	1.3860	20.500	76.500	03.000
6		1.4276	25.500	12.000	62.500	1.4090	41.500	54.500	04.000
7		1.4330	35.500	14.000	50.500	1.4380	64.000	32.200	03.800
8		1.4590	55.000	07.000	38.000	1.4615	81.500	15.500	03.000
9		1.4365	45.250	11.500	43.250	1.4510	72.750	23.750	03.500
10	80+20%	1.4120	01.800	02.100	96.1000	1.3960	30.800	65.300	03.940
11		1.4140	05.100	03.200	91.7000	1.4190	51.000	47.000	02.000
12		1.4154	06.200	02.500	91.3000	1.4442	65.500	32.000	02.500
13		1.4174	09.000	03.100	87.9000	1.4582	77.500	21.300	01.200

Table-34

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No.	%Dmf+Water	$R.I._E$	X_{TE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{TR}	X_{HR}	X_{DR+WR}
1	100+0	1.4288	09.750	13.250	77.000	1.3855	08.900	84.200	06.900
2		1.4300	16.000	19.500	64.500	1.3940	17.000	74.500	08.500
3		1.4302	20.500	35.000	44.500	1.4020	20.500	69.500	10.000
4		1.4301	18.000	27.000	55.000	1.3980	18.000	72.500	09.500
5		1.4294	12.870	18.000	64.130	1.3901	12.950	79.050	08.000
6	20+80	1.4140	02.000	01.000	97.000	1.4152	27.000	68.500	04.500
7		1.4230	04.000	01.000	95.000	1.4280	43.500	50.000	04.000
8		1.4271	08.500	01.200	90.300	1.4457	65.000	32.000	03.000
9		1.4280	10.000	01.000	89.000	1.4618	79.500	18.000	02.500
10		1.4250	06.250	01.000	92.750	1.4301	54.250	42.250	03.500

Table-35

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 30 °C

		Extract Phase				Reffinate Phase			
Sr.No.	%Dmf+Water	$R.I._E$	X_{TE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{TR}	X_{HR}	X_{DR+WR}
1	100+0	1.4200	03.500	17.000	79.500	1.3751	02.000	88.000	10.000
2		1.4212	08.250	17.500	74.250	1.3780	05.000	85.000	10.000
3		1.4230	13.000	18.000	69.000	1.3835	10.000	78.000	12.000
4		1.4240	15.000	22.000	63.000	1.3860	13.200	74.000	12.800
5		1.4260	19.000	28.000	53.000	1.3935	18.000	61.500	19.500
6	90+10	1.4235	07.800	04.800	87.400	1.3973	18.200	74.800	07.000
7		1.4282	12.600	06.000	81.400	1.4079	27.000	65.500	07.500
8		1.4295	15.000	06.000	79.500	1.4201	37.500	54.500	08.100
9		1.4365	25.000	03.500	71.500	1.4380	53.000	37.000	10.000
10		1.4441	37.000	03.000	60.000	1.4560	70.000	24.000	06.000
11	80+20%	1.4195	07.500	01.600	90.400	1.4271	45.000	50.500	04.500
12		1.4139	10.000	01.800	88.200	1.4315	49.000	46.500	04.500
13		1.4162	11.000	01.600	87.400	1.4461	61.000	35.500	03.500
14		1.4183	15.000	01.200	83.800	1.4615	74.000	23.000	03.000
15		1.4123	03.000	01.400	95.600	1.4531	67.500	29.500	03.000

Table-36

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmf(D) + Water(w) at 40 °C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{TE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{TR}	X_{HR}	X_{DR+WR}
1	100+0	1.4271	12.000	27.000	61.000	1.3840	08.500	71.500	20.000
2		1.4260	10.000	26.000	64.000	1.3817	07.000	76.500	16.500
3		1.4185	06.000	20.000	74.000	1.3791	04.000	81.000	15.000
4		1.4210	07.500	22.000	70.500	1.3810	06.000	79.000	15.000
5		1.4261	11.000	24.000	65.000	1.3831	07.700	74.000	18.300
7	90+10	1.4215	14.000	03.500	82.500	1.4350	52.000	36.500	11.500
8		1.4232	31.000	04.000	65.000	1.4524	69.500	24.000	06.500
9		1.4525	51.000	02.000	47.000	1.4747	86.000	13.000	01.000
10		1.4250	11.000	05.000	84.000	1.4222	31.000	51.000	10.000
11		1.4312	22.500	03.500	74.000	1.4431	60.700	29.300	10.000
12	80+20%	1.4119	03.000	02.100	94.400	1.3929	24.000	74.500	01.500
13		1.4170	08.000	18.000	90.200	1.4169	46.500	51.000	01.500
14		1.4301	25.000	01.500	73.500	1.4471	74.000	23.000	03.000
15		1.4141	05.000	02.000	93.000	1.4051	37.000	58.000	05.000
16		1.4221	16.000	02.000	82.000	1.4375	62.000	35.000	03.000

Table--37

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(W) at 20°C

Sr.No.	%Dmf+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{XR}	X_{HR}	X_{DR+WR}
1	100+0	1.4240	02.900	13.000	84.100	1.3747	01.990	96.150	01.500
2		1.4270	09.700	15.800	74.500	1.3821	08.900	87.800	03.300
3		1.4290	14.400	19.700	65.900	1.3916	16.250	79.800	03.950
4		1.4256	06.300	14.400	79.300	1.3790	05.440	92.150	02.400
5		1.4280	12.050	17.750	70.200	1.3830	10.840	83.800	05.360
6	90+10	1.4240	01.240	03.450	94.180	1.3852	08.220	86.500	05.280
7		1.4279	05.500	03.600	90.900	1.4215	36.500	59.150	04.350
8		1.4361	12.500	03.250	84.250	1.4550	66.000	30.950	03.050
9		1.4265	03.370	04.000	92.630	1.4040	22.360	72.540	05.100
10		1.4318	90.000	05.000	86.000	1.4391	51.250	44.750	04.000
11	80+20	1.4223	01.500	00.650	97.950	1.4175	35.900	61.000	03.100
12		1.4237	05.000	00.500	94.500	1.4571	70.500	28.000	01.500
13		1.4225	03.250	00.500	96.250	1.4420	53.200	44.000	02.800
14		1.4232	04.120	00.500	95.380	1.4465	61.850	35.950	02.200
15		1.4219	02.380	00.500	97.120	1.4275	44.400	526.000	03.000

Table-38:-

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(W) at 30°C

Sr.No.	%Dmf+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{XR}	X_{HR}	X_{DR+WR}
1	100+0	1.4239	09.700	17.050	73.250	1.3720	04.800	91.000	04.200
2		1.4267	12.700	19.400	67.900	1.3841	10.100	85.400	04.500
3		1.4312	16.800	22.050	60.650	1.3915	15.700	78.500	05.300
4		1.4283	14.300	20.700	65.000	1.3870	12.300	84.000	06.000
5		1.4295	15.300	21.500	63.200	1.3875	14.000	78.000	08.000
6									
7	90+10	1.4250	05.000	06.250	88.750	1.4015	21.000	73.200	05.800
8		1.4281	08.500	05.800	85.700	1.4191	35.000	59.500	05.500
9		1.4349	16.500	04.800	78.700	1.4460	57.000	38.000	05.000
10		1.4370	19.200	03.300	77.500	1.4510	62.000	33.500	04.900
11		1.4305	12.500	04.000	83.500	1.4330	46.000	48.000	06.000
12									
13	80+20	1.4175	01.200	02.600	96.200	1.4030	21.500	70.700	07.800
14		1.4187	02.900	02.000	95.100	1.4230	37.500	56.500	06.000
15		1.4200	04.700	02.000	93.3.	1.4420	53.500	41.300	05.200
16		1.4206	05.400	01.900	92.700	1.4521	63.000	32.900	04.100
17		1.4258	13.000	01.800	85.200	1.4619	79.500	17.800	02.700

Table-39

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmf(D) + Water(W) at 40°C

Sr.No.	%Dmf+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	X_{DE+WE}	$R.I._R$	X_{XR}	X_{HR}	X_{DR+WR}
1	90+10	1.4310	18.000	05.000	77.000	1.4620	63.500	32.000	04.500
2		1.4210	05.000	08.600	86.400	1.3985	22.500	71.850	05.650
3		1.4258	12.000	07.250	80.750	1.4262	41.000	53.700	05.300
4		1.4270	13.500	07.000	79.500	1.4460	52.000	43.300	04.700
5		1.4300	16.500	06.300	77.200	1.4500	54.500	41.000	04.500
6									
7	80+20	1.4143	04.100	03.100	92.800	1.4110	29.100	64.100	06.800
8		1.4145	06.200	03.900	90.900	1.4260	41.700	53.500	04.800
9		1.4147	08.200	01.700	90.100	1.4480	61.500	34.800	03.700
10		1.4146	07.200	03.400	88.900	1.4380	51.600	43.500	05.000
11		1.4144	05.150	23.200	91.650	1.4191	35.400	57.900	06.700

Table-40

Tie line data for the Quaternary System

Benzene(B)-Hept(H')-Dmf(D) + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	Dmf+Wa	$R.I._E$	X_{BE}	$X_{H'E}$	X_{DE+WE}	$R.I._R$	X_{BR}	$X_{H'R}$	X_{DR+WR}
1	100+0	1.4261	02.000	16.000	82.000	1.4020	02.200	90.300	07.500
2		1.4262	03.000	17.500	79.500	1.4022	03.700	88.500	07.800
3		1.4270	05.000	20.000	75.000	1.4077	07.800	77.000	15.200
4		1.4266	04.000	15.000	78.500	1.4060	05.750	83.200	11.050
5		1.4268	04.500	15.000	77.000	1.4075	06.770	81.230	12.000
6	90+10	1.4375	13.500	08.000	78.500	1.4255	33.750	64.850	01.400
7		1.4343	09.500	07.200	83.300	1.4134	20.000	78.550	01.450
8		1.4440	25.000	08.150	66.850	1.4500	56.500	75.019	01.310
9		1.4400	17.500	08.020	74.480	1.4400	47.500	51.100	01.400
10		1.4419	21.000	08.100	70.900	1.4455	52.500	46.150	01.350

Table-41

Tie line data for the Quaternary System

Benzene(B)-Hept(H')-Dmf(D) + Water(W) at 30°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{BE}	$X_{H'E}$	X_{DE+WE}	$R.I._R$	X_{BR}	$X_{H'R}$	X_{DR+WR}
1	100+0	1.4369	12.500	20.200	66.300	1.4128	11.500	78.000	10.000
2		1.4220	05.500	19.000	75.500	1.4005	04.500	81.000	14.500
3		1.4230	09.000	23.000	68.000	1.4079	08.000	75.000	14.500
4		1.4164	02.200	18.300	79.500	1.3960	01.000	91.000	08.000
5		1.4184	03.850	19.000	77.150	1.3970	02.750	86.750	10.500
6	90+10	1.4340	14.000	10.800	75.200	1.4181	24.100	71.000	04.900
7		1.4371	19.500	14.000	66.500	1.4320	42.500	54.000	03.000
8		1.4440	30.500	15.000	54.500	1.4406	51.200	45.400	03.400
9		1.4355	16.750	12.500	70.750	1.4250	33.200	63.200	03.500
10		1.4410	25.000	14.500	60.500	1.4360	46.850	50.650	02.500
11	80+20	1.4275	14.750	04.000	81.250	1.4465	54.750	43.250	02.000
12		1.4209	05.500	04.500	90.000	1.4169	24.000	74.000	02.000
13		1.4250	11.500	05.000	83.500	1.4335	43.500	55.500	01.000
14		1.4295	18.000	04.000	78.000	1.4588	66.000	31.000	03.000
15		1.4400	31.000	03.000	66.000	1.4670	71.500	24.000	04.500

Table-42

Tie line data for the Quaternary System

Benzene(B)-Hept(H')-Dmf(D) + Water(W) at 40°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{BE}	$X_{H'E}$	X_{DE+WE}	$R.I._R$	X_{BR}	$X_{H'R}$	X_{DR+WR}
1	100+0	1.4189	03.000	17.000	80.000	1.3980	02.000	90.000	08.000
2		1.4194	05.000	20.000	75.000	1.3990	03.000	86.000	11.000
3		1.4210	08.200	24.000	67.800	1.4000	04.200	83.400	12.400
4		1.4220	09.000	26.000	65.000	1.4013	05.000	81.500	13.500
5		1.4256	13.000	29.500	67.500	1.4030	06.500	79.000	14.500
6									
7	90+10	1.4235	10.500	10.700	78.800	1.4080	17.000	74.760	08.240
8		1.4320	23.000	11.600	65.400	1.4240	37.500	55.950	06.550
9		1.4380	37.000	11.000	52.000	1.4424	57.200	39.600	03.200
10		1.4282	16.750	10.700	72.550	1.4165	27.250	65.050	07.700
11		1.4365	30.000	11.500	58.500	1.4330	47.350	47.650	05.000
12									
13	80+20	1.4150	07.500	04.000	88.500	1.4270	38.000	57.000	05.000
14		1.4280	23.000	02.000	75.000	1.4500	65.000	32.000	03.000
15		1.4390	34.000	01.500	64.500	1.4650	80.000	17.500	02.500
16		1.4200	15.250	02.800	81.950	1.4365	51.500	44.500	04.000
17		1.4345	28.500	01.000	70.500	1.4570	72.500	24.800	02.700

Table--43

Tie line data for the Quaternary System

Benzene(B)-Oct(O)-Dmf(D) + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{BE}	X_{OE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{OR}	X_{DR+WR}
1	100+0	1.4260	03.900	07.250	88.850	1.3900	04.000	94.050	01.950
2		1.4290	09.500	09.700	81.100	1.3945	10.070	87.270	02.660
3		1.4300	11.000	10.100	73.900	1.4020	18.000	78.700	03.300
4		1.4355	18.000	13.700	68.600	1.4100	23.600	72.800	03.600
5		1.4370	20.100	14.800	65.100	1.4195	29.000	67.100	03.900
6		1.4397	23.500	16.900	59.600	1.4290	33.800	62.080	04.120
7	90+10	1.4320	12.500	04.900	82.600	1.4230	29.000	64.900	01.100
8		1.4285	07.500	04.700	87.800	1.4140	20.500	78.400	01.100
9		1.4260	05.000	04.500	90.500	1.4100	17.000	81.890	01.110
10		1.4300	10.000	04.800	85.200	1.4177	24.000	79.900	01.100
11		1.4330	15.000	04.900	80.100	1.4282	33.800	65.170	01.030
12	80+20	1.4225	08.850	00.700	90.450	1.4380	44.500	54.480	01.020
13		1.4190	02.100	00.520	97.380	1.4070	15.000	83.950	01.050
14		1.4210	03.700	00.620	95.670	1.4170	25.000	73.970	01.030
15		1.4235	14.000	00.850	85.150	1.4590	64.000	35.010	00.990
16		1.4344	22.000	00.850	77.150	1.4710	75.000	24.030	00.970

Table-44

Tie line data for the Quaternary System

Benzene(B)-Oct(O)-Dmf(D) + Water(W) at 30°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{BE}	X_{OE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{OR}	X_{DR+WR}
1	100+0	1.4280	12.700	12.300	75.000	1.3950	12.000	84.550	03.450
2		1.4310	16.500	14.100	69.400	1.3970	14.500	81.500	03.750
3		1.4325	18.800	15.200	66.000	1.4030	20.800	74.700	04.500
4		1.4345	21.200	16.100	62.700	1.4075	25.000	69.690	05.310
5		1.4365	23.500	17.500	59.000	1.4120	29.800	63.700	06.500
6	90+10	1.4270	07.500	05.950	86.550	1.4050	16.700	81.800	01.500
7		1.4310	12.800	07.000	80.200	1.4150	25.800	72.680	01.520
8		1.4350	17.800	07.550	74.650	1.4234	34.400	64.040	01.560
9		1.4425	27.400	07.970	64.630	1.4400	49.700	48.650	01.650
10		1.4465	32.010	07.750	60.250	1.4500	58.500	39.800	01.700
11	80+20	1.4208	07.000	02.560	90.490	1.4231	34.500	64.450	01.100
12		1.4240	11.200	02.850	85.950	1.4420	52.100	46.850	01.050
13		1.4320	20.000	03.150	76.850	1.4620	72.100	26.950	00.950
14		1.4230	09.100	02.800	88.100	1.4320	43.300	55.650	01.050
15		1.4280	15.600	03.000	81.400	1.4520	62.300	36.650	01.050

Table-45

Tie line data for the Quaternary System

Benzene(B)-Oct(O)-Dmf(D) + Water(W) at 40°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmf+Water	$R.I._E$	X_{BE}	X_{OE}	X_{DE+WE}	$R.I._R$	X_{BR}	X_{OR}	XDR+WR
1	100+0	1.4231	09.500	11.810	78.690	1.3873	07.500	88.850	03.650
2		1.4236	10.800	12.500	76.700	1.3877	08.300	87.950	03.750
3		1.4262	17.400	16.000	66.600	1.3920	14.500	80.930	04.570
4		1.4270	19.200	16.860	73.300	1.3928	16.000	79.280	04.720
5		1.4285	24.000	21.000	55.000	1.4035	24.000	69.000	07.000
6	90+10	1.4215	11.000	05.000	84.000	1.3991	11.000	85.000	04.000
7		1.4240	17.000	07.000	76.000	1.4089	20.000	76.000	04.000
8		1.4300	30.000	09.000	61.000	1.4210	31.000	64.000	05.000
9		1.4340	41.000	09.000	50.000	1.4340	42.000	52.000	06.000
10		1.4372	51.000	06.000	43.000	1.4455	52.000	41.500	06.500
11	80+20	1.4150	05.000	04.100	90.100	1.3989	11.800	85.500	02.700
12		1.4170	07.500	04.100	88.400	1.4072	20.300	76.600	03.100
13		1.4200	12.500	02.300	85.200	1.4179	31.900	65.000	03.100
14		1.4279	14.000	01.700	84.300	1.4239	36.400	60.000	03.600
15		1.4179	10.000	03.000	87.000	1.4121	26.100	70.400	03.500

Table-46

Tie line data for the Quaternary System

Benzene(B)- Hexane (H)-Dmso(D') + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{BE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4838	18.140	06.500	75.360	1.4005	23.000	75.000	03.000
2		1.4848	22.000	07.000	71.000	1.4186	33.000	65.500	01.500
3		1.4854	24.000	07.000	69.000	1.4333	41.500	56.000	02.500
4		1.4864	27.000	06.000	67.000	1.4380	45.000	51.970	03.030
5		1.4868	31.000	07.950	64.040	1.4450	51.000	46.000	03.000
6		1.4852	23.000	05.790	71.200	1.4235	36.000	62.000	02.000
7									
7	90+10	1.4050	03.000	01.000	96.000	1.4000	20.000	78.000	02.000
8		1.4696	13.000	01.000	86.000	1.4100	35.000	63.000	02.000
9		1.4600	12.000	01.000	87.000	1.4331	48.500	49.000	02.500
10		1.4710	36.000	01.000	63.000	1.4610	61.000	32.000	07.000
11		1.4700	21.500	01.000	77.500	1.4835	81.500	14.000	04.500
12	80+20	1.4518	01.000	00.020	98.980	1.4036	24.300	74.200	01.500
13		1.4525	02.000	00.020	97.980	1.4071	47.500	50.500	02.000
14		1.4528	05.000	00.020	94.980	1.4617	77.000	21.000	02.000
15		1.4531	06.500	00.020	93.480	1.4830	89.000	10.000	01.000

Table-47

Tie line data for the Quaternary System

Benzene(B)- Hexane (H)-Dmso(D') + Water(W) at 30°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{BE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4655	08.000	02.000	90.000	1.3082	15.000	82.000	03.000
2		1.4600	15.700	04.800	79.500	1.3720	25.610	73.000	01.390
3		1.4585	23.800	06.500	69.700	1.3980	37.100	60.400	02.790
4		1.4638	36.800	08.000	55.200	1.4180	44.700	48.100	07.200
5		1.4671	44.500	16.300	39.200	1.4500	50.400	36.000	13.600
6		1.4572	19.500	05.000	74.500	1.3300	31.000	70.000	04.000
7		1.4670	04.000	04.000	92.000	1.3084	16.500	81.000	02.500
8	90+10	1.4535	05.000	05.000	94.500	1.3550	16.500	82.000	01.500
9		1.4540	08.750	00.750	90.500	1.3831	30.250	68.000	01.750
10		1.4542	11.500	00.900	88.600	1.4060	40.500	58.100	01.400
11		1.4550	15.000	01.000	84.000	1.4430	55.500	42.500	02.000
12		1.4552	17.500	01.000	81.500	1.4550	67.000	31.000	02.000
13		1.4541	10.000	00.800	89.200	1.3910	36.000	63.000	01.000
14	80+20	1.4427	00.400	00.100	99.500	1.3500	13.500	85.500	01.000
15		1.4432	00.800	00.100	99.100	1.4105	25.700	73.200	01.100
16		1.4437	01.700	00.100	98.200	1.4470	46.500	53.200	00.300
17		1.4440	02.200	00.200	97.600	1.4640	67.200	32.000	00.700
18		1.4435	01.200	00.100	98.700	1.4315	36.000	62.500	01.500

Table-48

Tie line data for the Quaternary System

Benzene(B)- Hexane (H)-Dmso(D') + Water(W) at 40°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{BE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4680	07.500	04.000	88.500	1.4059	15.000	80.000	05.000
2		1.4688	16.000	04.000	89.000	1.3855	26.600	70.560	02.770
3		1.4711	25.500	07.500	67.000	1.3880	33.000	63.000	04.000
4		1.4731	34.500	08.600	56.900	1.3960	38.000	59.000	03.000
5	90+10	1.4577	10.500	02.000	87.000	1.4070	34.500	64.300	01.200
6		1.4601	18.000	04.000	83.500	1.4290	49.300	49.800	01.000
7		1.4588	15.000	02.000	83.000	1.4180	42.200	56.800	01.000
8		1.4562	06.000	02.000	92.000	1.3815	15.000	84.000	01.000
9		1.4614	23.700	04.000	72.300	1.4238	56.500	40.000	01.500
10	80+20	1.4430	01.300	00.100	98.700	1.3850	14.300	84.300	01.400
11		1.4438	02.300	00.100	97.500	1.4071	35.500	63.500	01.000
12		1.4470	08.200	00.100	89.500	1.4251	50.300	49.000	00.700
13		1.4421	00.600	00.050	99.300	1.3779	07.200	91.500	01.300
14		1.4434	01.800	00.100	98.100	1.3961	25.000	73.000	02.000

Table-49

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{TE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{TR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4728	13.000	05.000	82.000	1.4435	27.000	70.500	02.500
2		1.4600	25.000	05.000	70.000	1.4645	57.000	38.500	04.500
3		1.4772	30.500	09.500	60.000	1.4640	56.000	26.000	17.000
4		1.4741	18.000	05.000	77.000	1.4550	43.000	54.000	03.000
5		1.4737	16.500	05.000	78.500	1.4485	35.100	62.200	02.700
6		1.4751	21.800	05.000	73.200	1.4595	50.000	46.000	04.000
7	90+10	1.4620	07.500	00.500	92.000	1.4460	60.000	32.100	07.900
8		1.4635	09.500	00.500	90.000	1.4550	68.000	28.100	03.900
9		1.4657	12.000	00.100	87.900	1.4721	82.000	17.500	00.500
10		1.4610	05.000	00.100	94.900	1.4355	49.000	44.200	06.800
11		1.4595	03.500	00.100	96.400	1.4228	37.000	58.100	04.800
12	80+20	1.4531	01.000	00.010	98.990	1.4133	29.000	70.000	01.000
13		1.4535	02.000	00.010	97.990	1.4518	65.000	33.500	01.500
14		1.4538	02.200	00.010	97.790	1.4140	69.500	29.000	01.500
15		1.4540	03.500	00.010	96.190	1.3960	84.000	14.500	01.500
16		1.4534	01.500	00.010	98.490	1.4395	47.000	51.500	01.500

Table-50

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(W) at 30°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{TE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{TR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4698	16.500	04.000	79.500	1.4160	28.000	70.000	02.000
2		1.4695	10.500	05.000	84.500	1.4001	12.000	84.500	03.500
3		1.4699	23.400	04.000	74.600	1.4348	47.000	49.000	04.000
4		1.4696	12.000	05.000	83.000	1.4060	16.250	82.250	01.500
5		1.4697	14.500	04.000	81.500	1.4103	24.000	74.000	02.000
6		1.4698	18.500	04.000	77.500	1.4205	32.000	64.000	04.000
7	90+10	1.4569	04.300	01.500	94.200	1.3955	23.000	74.000	03.000
8		1.4578	05.000	01.500	93.500	1.4220	43.000	55.000	02.000
9		1.4580	06.750	01.300	91.950	1.4405	63.000	34.000	03.000
10		1.4618	15.000	02.000	83.000	1.4680	89.500	15.000	01.500
11		1.4608	13.000	02.000	85.000	1.4520	73.000	24.500	02.500
12	80+20	1.4428	00.800	00.320	98.880	1.3945	23.000	75.000	02.000
13		1.4430	01.500	00.300	98.200	1.4165	44.000	54.000	02.000
14		1.4440	02.000	00.200	97.800	1.4390	66.000	32.000	02.000
15		1.4460	02.500	00.100	97.400	1.4615	84.000	15.000	01.000
16		1.4429	01.100	00.320	98.580	1.4060	34.000	65.500	00.500

Table-51

Tie line data for the Quaternary System

Toluene (T) Hexane (H)-Dmso(D') + Water(W) at 40°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{TE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{TR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4679	22.000	06.000	72.000	1.3960	25.000	73.000	02.000
2		1.4682	25.500	08.000	70.240	1.4040	35.000	64.000	01.000
3		1.4687	30.000	07.500	62.500	1.4200	45.500	50.700	03.800
4		1.4690	33.000	09.600	57.390	1.4277	51.000	43.500	05.500
5		1.4680	23.300	07.500	69.200	1.4020	30.800	67.200	02.000
6		1.4684	27.500	07.940	64.550	1.4135	40.500	57.280	02.210
7	90+10	1.4605	09.730	00.770	89.500	1.4183	42.000	53.000	05.000
8		1.4615	14.000	00.500	85.500	1.4389	58.000	33.500	08.500
9		1.4627	21.360	00.440	78.200	1.4679	82.000	13.000	05.000
10		1.4611	12.000	02.000	86.000	1.4320	51.000	43.000	06.000
11		1.4618	17.600	01.400	81.000	1.4530	71.000	18.500	10.500
12	80+20	1.4355	02.600	00.380	97.020	1.3945	23.500	74.000	02.500
13		1.4465	04.350	00.200	95.400	1.4197	45.000	51.000	04.000
14		1.4477	06.200	00.230	93.670	1.4426	63.000	33.000	04.000
15		1.4451	03.620	00.380	96.000	1.4061	34.250	63.000	02.750

Table-52

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 20°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{XR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4732	00.700	01.900	97.400	1.4262	42.000	56.000	02.000
2		1.4741	02.000	01.930	96.070	1.4410	54.500	43.200	02.300
3		1.4745	04.000	02.000	94.000	1.4610	71.000	25.900	03.100
4		1.4742	02.400	01.600	96.000	1.4470	59.000	38.110	02.880
5		1.4744	02.950	02.800	95.160	1.4571	67.500	28.790	03.700
6		1.4743	02.600	01.800	95.600	1.4523	64.500	32.800	02.700
7	90+10	1.4607	00.180	00.960	98.860	1.4340	43.000	52.800	04.200
8		1.4608	00.200	00.950	98.850	1.4555	50.500	36.350	05.150
9		1.4609	00.250	00.940	98.810	1.4574	60.500	34.300	05.200
10		1.4610	00.300	00.920	98.780	1.4605	71.000	23.950	05.050
11		1.4611	00.400	00.900	98.700	1.4785	81.000	14.770	04.230
12	80+20	1.4501	00.100	00.590	99.325	1.4385	49.000	46.360	02.640
13		1.4501	00.130	00.600	99.000	1.4570	64.500	32.800	02.700
14		1.4501	00.200	00.750	99.050	1.4730	79.000	18.850	02.350
15		1.4501	00.300	00.750	98.950	1.4840	90.000	08.200	01.800
16		1.4501	00.100	00.600	99.300	1.4210	34.000	63.500	02.500

Table-53

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 30°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{XR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4735	05.750	02.410	91.850	1.4071	28.500	69.080	02.420
2		1.4740	08.500	02.600	88.400	1.4192	38.000	59.300	02.700
3		1.4743	10.000	02.700	87.300	1.4470	60.050	36.010	03.940
4		1.4745	11.750	02.800	85.450	1.4520	64.500	31.350	04.150
5		1.4738	06.700	02.760	90.540	1.4121	32.500	64.870	02.630
6		1.4741	09.250	02.600	88.150	1.4322	49.000	47.100	03.900
7	90+10	1.4181	00.800	01.100	98.100	1.4181	46.000	44.500	09.500
8		1.4289	01.000	01.000	98.000	1.4289	47.000	43.900	09.100
9		1.4609	01.500	00.900	97.600	1.4520	66.500	25.000	08.500
10		1.4610	01.920	00.770	97.310	1.4665	76.700	17.550	05.750
11		1.4608	00.650	01.100	98.250	1.4100	31.000	60.000	09.000
12	80+20	1.4471	00.150	00.940	98.910	1.4136	31.500	63.000	05.500
13		1.4471	00.250	00.960	98.790	1.4391	54.200	37.100	05.700
14		1.4471	00.350	00.910	98.740	1.4628	74.000	21.800	04.200
15		1.4471	00.200	00.950	98.850	1.4280	44.350	50.050	05.600
16		1.4471	00.300	00.930	98.770	1.4135	65.600	29.400	05.000

Table-54

Tie line data for the Quaternary System

Xylene(X)- Hexane (H)-Dmso(D') + Water(W) at 40°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{XE}	X_{HE}	$X_{D'E+WE}$	$R.I._R$	X_{XR}	X_{HR}	$X_{D'R+WR}$
1	100+0	1.4688	10.600	01.790	87.600	1.4285	19.400	77.290	03.310
2		1.4689	12.500	02.000	85.500	1.4335	23.500	74.500	03.000
3		1.4690	14.000	03.160	82.840	1.4380	29.500	66.150	04.350
4		1.4695	16.000	03.000	79.000	1.4410	35.000	60.000	05.000
5		1.4705	19.200	01.300	79.500	1.4440	47.500	48.000	04.500
6		1.4700	18.250	02.050	79.690	1.4430	41.000	54.090	04.910
7	90+10	1.4571	01.700	01.260	97.040	1.4240	05.000	90.050	04.950
8		1.4573	02.500	01.000	96.500	1.4270	08.600	86.700	04.700
9		1.4575	04.000	00.550	95.450	1.4335	18.000	75.600	06.400
10		1.4572	02.100	01.150	96.750	1.4260	06.800	88.400	04.800
11		1.4574	03.250	00.700	96.050	1.4300	13.300	91.700	05.000
12	80+20	1.4427	01.400	02.000	96.100	1.4335	06.500	83.500	10.000
13		1.4428	01.800	01.000	97.200	1.4345	10.000	80.000	10.000
14		1.4428	02.300	00.500	97.200	1.4365	16.500	73.500	10.000
15		1.4427	01.600	01.000	97.400	1.4340	08.250	81.750	10.000
16		1.4428	02.050	00.500	97.450	1.4357	13.250	76.750	10.000

Table-55

Tie line data for the Quaternary System

Benzene(B)- Hept (H')-Dmso(D') + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{BE}	$X_{H'E}$	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4686	12.000	03.400	84.600	1.4140	23.000	74.700	02.300
2		1.4718	17.900	04.200	79.900	1.4190	30.000	67.450	02.550
4		1.4744	20.600	04.860	74.540	1.4335	42.700	43.700	03.600
5		1.4758	23.900	04.110	71.980	1.4420	49.000	46.350	04.650
6	90+10	1.4615	00.500	00.750	98.750	1.4154	15.700	81.680	02.620
7		1.4625	06.100	00.650	93.250	1.4245	26.600	70.050	03.350
8		1.4640	11.100	00.560	88.340	1.4345	37.300	58.500	04.200
9		1.4660	17.900	00.450	81.650	1.4450	48.600	46.490	04.910
10		1.4676	25.000	00.300	74.700	1.4550	59.100	35.650	05.250
11		1.4685	29.000	00.250	70.750	1.4640	66.700	28.200	05.100
13	80+20	1.4495	02.200	00.300	97.500	1.4005	07.100	91.900	01.000
14		1.4509	04.000	00.250	95.750	1.4210	20.000	78.900	01.100
15		1.4517	05.200	00.200	94.600	1.4290	30.000	68.800	01.200
16		1.4527	06.500	00.150	93.350	1.4370	44.500	54.200	01.300
17		1.4533	07.500	00.100	92.400	1.4455	52.100	46.400	01.500
18		1.4522	05.850	00.150	94.000	1.4345	37.250	61.450	01.300

Table-56

Tie line data for the Quaternary System

Benzene(B)- Hept (H')-Dmso(D') + Water(W) at 30°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{BE}	$X_{H'E}$	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4620	13.000	05.000	78.000	1.4107	28.000	69.000	03.000
2		1.4682	16.700	04.890	78.400	1.4210	31.500	65.890	02.600
3		1.4700	18.500	05.200	76.500	1.4240	36.000	58.250	05.750
4		1.4720	21.000	05.500	73.500	1.4315	43.000	53.000	04.000
5		1.4745	27.500	06.390	66.100	1.4470	50.000	38.820	11.180
6		1.4750	31.000	06.000	63.000	1.4575	52.000	33.500	14.000
7	90+10	1.4620	05.800	00.830	93.370	1.4131	17.500	78.450	04.050
8		1.4634	11.000	00.800	88.200	1.4270	32.200	64.060	03.740
9		1.4650	16.000	00.620	83.380	1.4370	42.500	54.100	03.400
10		1.4670	20.000	00.570	79.420	1.4540	60.500	36.550	02.950
11		1.4672	23.000	00.450	76.550	1.4620	68.100	29.300	02.600
12	80+20	1.4500	02.000	00.500	97.500	1.4095	06.500	91.000	02.500
13		1.4510	04.000	00.500	95.500	1.4200	17.700	79.900	02.400
14		1.4530	07.000	00.500	92.500	1.4300	28.000	69.700	02.300
15		1.4545	11.000	00.500	88.500	1.4455	45.850	51.950	02.200
16		1.4570	16.000	00.500	85.500	1.4610	63.700	34.200	02.100

Table-57

Tie line data for the Quaternary System

Benzene(B)- Hept (H')-Dmso(D') + Water(W) at 40°C

Sr.No	%Dmso+Water	Extract Phase				Reffinate Phase			
		$R.I._E$	X_{BE}	$X_{H'E}$	$X_{D'E+WE}$	$R.I._R$	X_{BR}	$X_{H'R}$	$X_{D'R+WR}$
1	100+0	1.4730	14.000	07.000	79.000	1.4170	20.500	72.500	07.000
2		1.4735	17.500	08.000	74.500	1.4200	30.000	64.000	06.000
3		1.4738	20.000	09.000	71.000	1.4302	43.000	49.000	08.000
4		1.4753	30.000	10.000	60.000	1.4320	52.000	32.000	16.000
5		1.4747	26.000	10.000	64.000	1.4370	48.000	41.800	09.200
6		1.4733	15.900	07.650	76.440	1.4160	25.500	67.100	07.390
7	90+10	1.4597	05.500	01.400	93.100	1.4026	07.520	88.880	03.600
8		1.4611	09.000	01.250	89.750	1.4111	16.500	80.000	03.500
9		1.4641	18.500	01.000	80.500	1.4340	40.500	56.350	03.150
10		1.4681	30.500	00.900	68.600	1.4590	66.700	30.550	02.750
11		1.4660	24.500	00.900	74.600	1.4465	53.600	43.550	02.850
12	80+20	1.4510	00.900	01.200	97.850	1.4061	12.600	84.200	03.200
13		1.4550	05.000	01.500	93.500	1.4015	08.000	89.000	03.000
14		1.4595	08.000	01.500	90.500	1.4120	19.000	78.100	02.900
15		1.4680	15.000	01.500	83.500	1.4320	39.000	58.200	02.800
16		1.4720	21.000	01.500	77.500	1.4500	57.000	40.300	02.700
17		1.4700	18.000	01.500	80.500	1.4410	48.000	49.300	02.700

Table-58

Tie line data for the Quaternary System

Benzene(B)- Oct (O)-Dmso(D') + Water(W) at 20°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{BE}	X_{OE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	X_{OR}	$X_{D'R+WR}$
1	100+0	1.4707	01.000	01.000	98.000	1.4060	19.000	80.350	00.650
2		1.4708	02.800	01.200	96.000	1.4135	29.300	70.150	00.550
3		1.4724	08.000	01.500	92.500	1.4391	42.000	57.320	00.680
4		1.4719	16.000	02.700	81.800	1.4430	43.500	55.750	00.750
5		x1.4733	31.500	04.000	64.500		53.000	41.000	06.000
6		1.4710	03.700	01.430	94.870	1.4200	33.500	65.430	01.070
7	90+10	1.4618	05.000	00.010	94.930	1.4260	49.500	50.000	00.500
8		1.4825	08.500	00.140	91.360	1.4365	59.000	40.500	00.500
9		1.4640	17.000	00.120	82.880	1.4480	67.000	32.260	00.740
10		1.4650	34.000	00.070	65.930	1.4660	78.000	19.800	02.200
11		1.4620	06.750	00.080	93.170	1.4310	54.250	40.750	00.500
12	80+20	1.4511	04.150	00.300	95.550	1.4651	76.000	23.550	00.450
13		1.4500	01.100	00.450	98.450	1.4369	57.000	42.550	00.450
14		1.4509	02.800	00.350	96.850	1.4571	71.000	28.550	00.450
15		1.4524	05.500	00.250	94.250	1.4722	81.000	18.550	00.450
16		1.4503	01.950	00.400	98.650	1.4465	64.000	35.550	00.450

Table-59

Tie line data for the Quaternary System

Benzene(B)- Oct (O)-Dmso(D') + Water(W) at 30°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{BE}	X_{OE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	X_{OR}	$X_{D'R+WR}$
1	100+0	1.4725	10.500	01.900	95.100	1.4050	31.000	67.600	01.400
2		1.4747	16.000	02.650	81.550	1.4185	37.300	61.100	01.600
3		1.4728	10.150	02.000	93.400	1.4055	31.500	67.080	01.420
4		1.4758	23.000	03.150	73.850	1.4461	45.000	53.200	01.800
5		1.4771	30.600	04.400	65.000	1.4800	52.500	45.600	01.900
6		1.4720	01.000	01.800	97.200	1.3930	23.500	75.400	01.100
7	90+10	1.4600	02.000	00.200	97.800	1.4130	27.500	71.650	00.850
8		1.4630	11.500	00.110	88.390	1.4290	52.000	47.350	00.650
9		1.4685	30.000	00.090	69.910	1.4390	66.500	32.650	00.850
10		1.4730	40.000	00.050	59.950	1.4410	72.000	26.550	01.450
11		1.4655	20.750	00.100	78.250	1.4345	59.250	39.850	00.900
12	80+20	1.4475	01.300	00.050	98.650	1.4127	43.000	56.400	00.600
13		1.4492	03.000	00.040	96.960	1.4235	55.000	44.600	00.400
14		1.4502	04.500	00.030	95.470	1.4335	64.000	35.600	00.400
15		1.4528	08.500	00.020	91.480	1.4427	71.000	28.250	00.750
16		1.4477	02.150	00.050	97.800	1.4180	49.000	50.500	00.500

Table-60

Tie line data for the Quaternary System

Benzene(B)- Oct (O)-Dmso(D') + Water(W) at 40°C

		Extract Phase				Reffinate Phase			
Sr.No	%Dmso+Water	$R.I._E$	X_{BE}	X_{OE}	$X_{D'E+WE}$	$R.I._R$	X_{BR}	X_{OR}	$X_{D'R+WR}$
1	100+0	1.4685	05.350	00.790	93.850	1.3875	24.700	74.620	00.670
2		1.4700	18.200	01.970	79.820	1.4390	44.000	55.210	00.790
3		1.4730	36.500	06.370	57.120	1.4050	52.200	32.260	15.530
4		1.4682	03.000	02.550	94.450	1.3840	19.500	79.150	01.350
5		1.4690	17.500	02.950	79.550	1.3990	31.500	66.650	01.850
6		1.4697	21.300	03.150	75.550	1.4075	35.500	62.650	01.850
7		1.4730	36.500	06.370	57.120	1.4298	42.000	56.150	01.950
8	90+10	1.4557	01.700	00.240	98.060	1.3930	18.000	79.840	02.160
9		1.4620	19.400	00.200	80.400	1.4230	56.500	42.250	01.250
10		1.4574	07.000	00.220	92.780	1.4050	36.500	61.800	01.700
11		1.4565	04.350	00.220	95.430	1.3982	27.200	70.750	02.000
12		1.4591	13.200	00.200	86.600	1.4140	46.500	52.000	01.500
13	80+20	1.4407	02.090	00.110	97.800	1.4081	42.000	57.200	00.800
14		1.4450	03.800	00.070	96.100	1.4120	54.000	45.350	00.650
15		1.4525	10.000	00.080	89.200	1.4400	71.000	28.510	00.490
16		1.4458	07.040	00.050	92.900	1.4640	83.500	16.100	00.400

4.2.0 Liquid-Liquid Extraction of Aromatics in a Packed Column

4.2.1 Packed Column Details:

Based on properties of dispersed phase and continuous phase like density , viscosity and interfacial tension etc., the critical size of packing [161] for the two solvents under consideration for systems – Benzene + Hexane + Dmf + Water and Benzene + Hexane + Dmso + Water can be estimated The critical size so estimated was of the order of 0.391cm. Hence, the packing size to be utilised has to be above the critical size of packing in order to have droplet diameter of dispersed phase to be independent of the packing size.

Hence packing size of the order of 0.7 cm was utilised in this investigation for a 5cm diameter column. Also packing size of the order of 1.25 cm was also utilised in this investigation for a 15 cm diameter column.

Puranik and Sharma[127] have studied various liquid-liquid extraction systems in packed columns of different diameters ranging from 2.5 to 15 cm and different heights. From the conclusions drawn by these authors and others,[152,159] it appears that to avoid the wall effects, the ratio of the column diameter to the packing size should be greater than 7 to 8. Hence a packed column having internal diameter of 5 cm was used in this investigation. Further to avoid end effects, the packed height utilized was 118.5 cm . Hence it is expected, that the results obtained are expected to be independent of column diameter, packed height and the diameter of packing.

All the experimental runs under different sets of conditions were taken in a packed column of 5 cm diameter packed with Raschig rings of 0.7 cm diameter.

However, later on , some selected runs were also take in a bigger column of 15 cm diameter packed with Raschig rings of 1.25 cm diameter in order to do scale up and to have applicability of Laboratory Scale Data in Industrial practise in a Petroleum refinery.

The pertinent details regarding column and the salient characteristics of packing are reported in Table-B.The relevant details mentioned by Tare and Puranik[159] Sadhana and Puranik [152] are expected to be very useful in this regard.

4.2.2 Experimental Set up:-

Typical experimental set-up consisting of Feed Tank, Solvent Tank, rotameters and a packed column is shown in Fig..I which is a photograph of complete set up of Liquid-Liquid extraction unit.

A schematic diagram of the extraction unit is also shown in Fig .II.

4.2.3. Operating Proceedure:

(i) Flooding velocities:-

The flooding velocities were calculated by the equations proposed by Crawford and Wilke[10] for the system-Benzene-Hexane-Dmf containing 20% water by weight and also for Benzene-Hexane-Dmso containing 20% water by weight and the column was operated well below the flooding velocities to avoid the dispersed being swept out of the column by the continuous phase.

(ii) Dispersed and continuous phase:-

All the experimental runs were performed at 30^{0}C for solvent Dmf and at 40 ^{0}C for solvent Dmso using different S/F ratio values and corresponding Vd and Vc values. Since the solvent (Dmf)/(Dmso) is likely to wet the pickings, it was used as the continuous phase. Dispersed phase consisted of a feed containing 50% Benzene and 50% n-Hexane by weight.

Table (B)

Details regarding Packed Column Characteristics &Operating Parameters

Sr. No.	Description		Size	
(1)	Column diameter	O.D.	6 cms	15 cms
		I.D.	5 cms	13.7 cms
(2)	Packed height		118.5 cms	108.0 cms
(3)	Column volume		2312 cms^3	16092 cms^3
	Effective volume		1400 cms^3	9252 cms^3
(4)	Cross sectional area of column		19.625 cm^2	149.11 cm^2
(5)	O.D.Packing		0.7cm	1.25 cm
(6)	Packing size:I.D packing		0.5 cm	0.75 cm
(7)	Length of one Packing		0.7cms	1.25 cm
(8)	Dry area of packing		3.02 cm^2/cm^3	3.42cm^2/cm^3
(9)	Packing at voidage		0.602	0.575

(i) Feed : Dispersed Phase :

50%Benzene + 50% n-Hexane by weight — Density=0.785 gm/cm^3 at 30 ^{0}C

(for both solvents-Dmf+Dmso)

(ii) Solvent :

(1) 80%Dmf containing 20% water by weight — Density= 0.96 gm/cm^3 at 30 ^{0}C

(2)80%Dmso containing 20% water by weight — Density= 1.08 gm/cm^3 at 40 ^{0}C

Foot Note :-Sadhana Sukla 152,162 has operated * 10 cm dia. And 15 cm dia columns as a direct contact heat exchanger for liquid-liquid heat transfer in the region of dense packing of drops. The same experimental set up was utilized to carry liquid-liquid extraction of aromatics for a very few selected runs for solvent Dmf and Dmso . Newer solvent being costly in nature , only restricted numberiof runs were taken on large scale due to financial reasons/constraints.

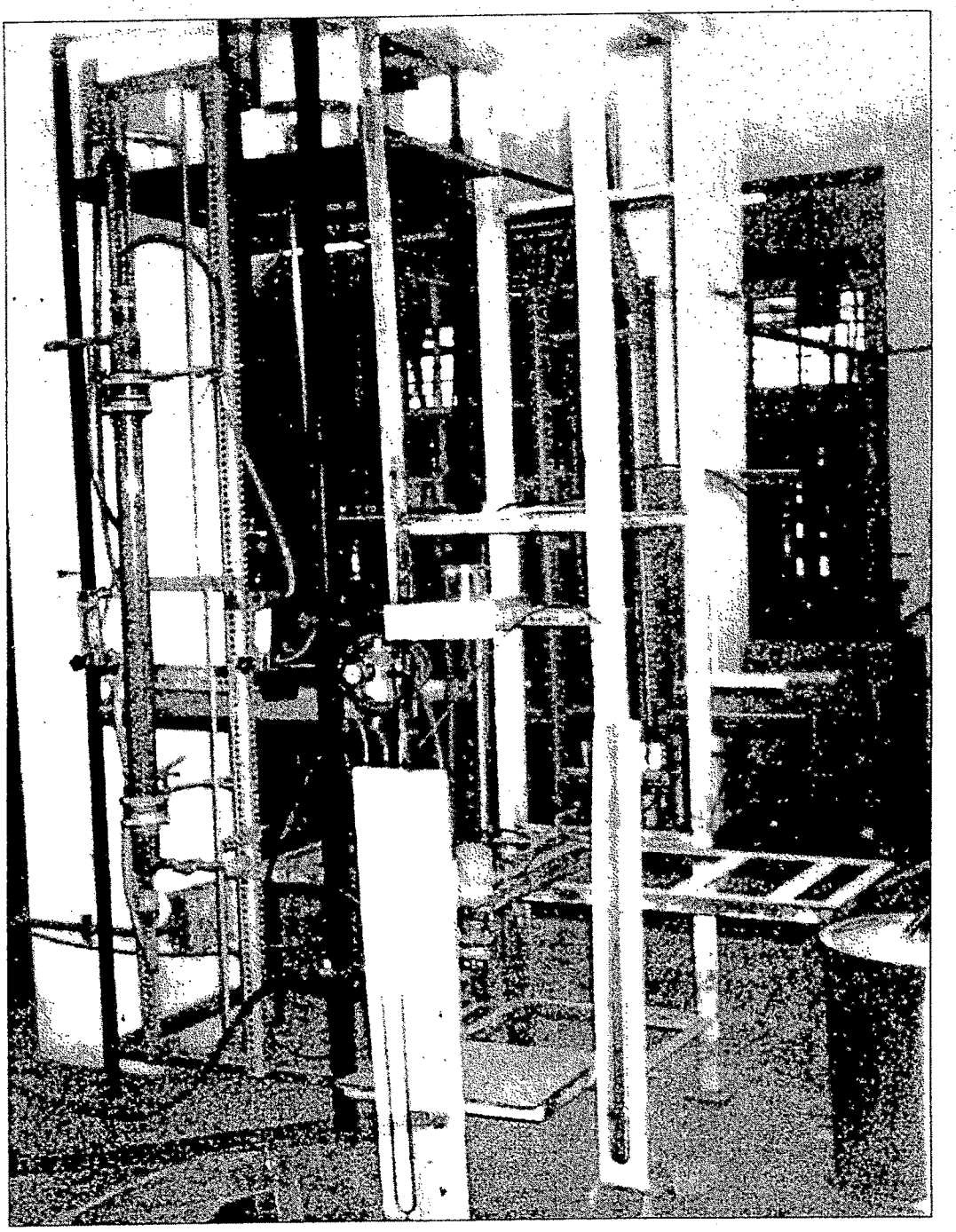

Fig. – (I)-Experimental Set up

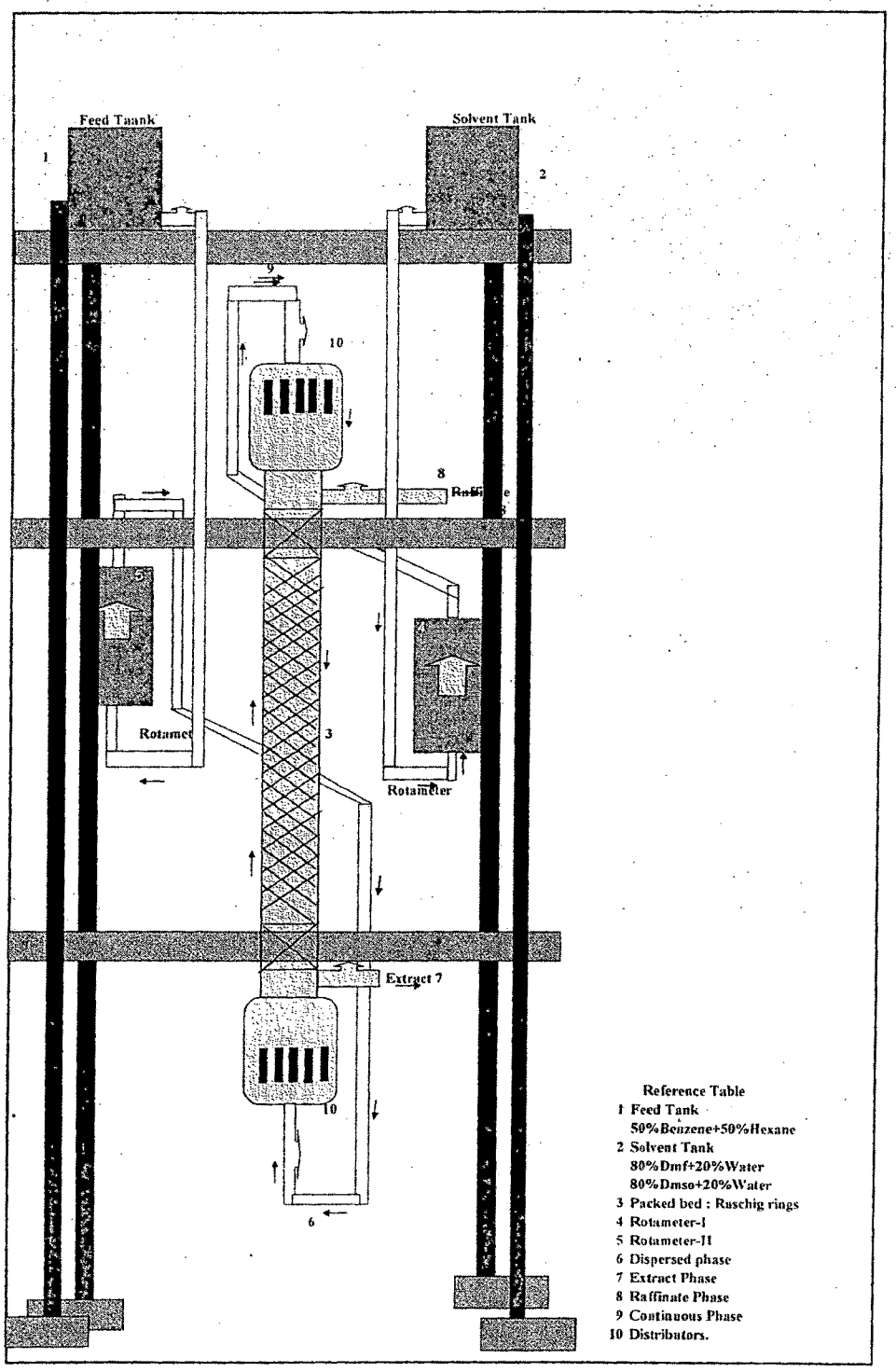

Fig .II Schematic diagram of Liquid-Liquid Extraction unit .

(iii) Measurement of Holdup:-

In general, experimental holdup measurements[159] are carried out by one of the two methods.

Method-(I):-Draining method in which the volume held up is measured by draining the column and separating the desired phases.

Method-(II):- Displacement method which gives the free or normal hold up.

The displacement method involves operating the column until steady flow conditions are reached and then simultaneously stopping all the inlet and exit streams after ascertaining the exact position of the interface. The interface then could be observed to descend slowly owing to the accumulation of the dispersed phase hold up in the column pushing down the continuous phase. When no further movement of the interface is observed, the continuous phase supply is turned on gradually and the dispersed phase liquid collected at the top is allowed to be displaced out of the column into a receiver. When the interface level at the top regains its exact original position ,the continuous phase supply is stopped instantly. The volume of the displaced liquid is then determined and the ratio of this volume to the actual void volume in the column is calculated to obtain the value of dispersed phase hold up.

(iv) Finding out compositions of Extract phase/ Raffinate phase :-

'When steady state is reached in column, the refractive index of out going dispersed phase and continuous phase were taken . Refractive Index of extract phase and raffinate phase were measured as $R.I._E$ and $R.I._R$.

R.I. Vs. composition charts presented in Appendix-(I): Figures.E. 1-.6 for solvent Dmf and Figures E. 2-.9 for solvent Dmso could be utilized conveniently to find out X_{BE}, X_{HE}, X_{DE} for extract phase and Figures R. 1-.6 for solvent Dmf and Figures R. 2-.9 for solvent Dmso could be utilized conveniently to find out X_{BR}, X_{HR}, X_{DR} for raffinate phase.

4.2.4. Operating Variables:-

(i) Temperature of column :- Taking in to advantage of climatic changes / variations in temperature during Winter/ Summer , Liquid-liquid extraction of aromatics in a packed column for system involving – Benzene-Hexane-Dmf-Water was performed in Winter. All experimental runs were taken when temperature was about 30 ^{0}C for system B-H-Dmf –W.

Liquid-liquid extraction of aromatics in a packed column for system involving – Benzene-Hexane-Dmso-Water was performed in Summer. All experimental runs were taken when temperature was about 40 ^{0}C for system B-H-Dmso -W.

(ii)Ranges of Vc , Vd and S/F ratio:-

Continuous phase flow rate (Vc)*:
From 0.20 cm/min to 2.0 cm/min for solvent Dmf.
From 0.25 cm/min to 1.0 cm/min for solvent Dmso.

Dispersed phase flow rate (Vd) * :
From 0.1 cm/min to 0.70 cm/min for solvent Dmf.
From 0.20 cm/min to 2.0 cm/min for solvent Dmso
Solvent to Feed ratio (S/F) :
From 1.0 by wt. to 10.0 by wt. for solvent Dmf.
From by vol.0.96 to 9.6 by vol. for solvent Dmf.
From 0.5 by wt. to 5.0 by wt. for solvent Dmso
From 0.54 by vol. to 5.4 by vol. for solvent Dmso

Note:-*Due care was taken to see all the flow rate –ranges of Vc and Vd were well below the flooding velocities.

Note:-*Due care was taken to see all the flow rate –ranges of Vc and Vd were well below the flooding velocities.

4.2.5 Data Tables for Liquid-Liquid Extraction of aromatics in a packed column:-

(I) Experimental observations and Data Tables for liquid-liquid extraction of aromatics consisting of Feed –Benzene+Hexane as dispersed phase and mixed solvent – Dmf+ Water as continuous phase are reported in Tables – (I) to (V)

Table-(I): Observations recorded for Packed column operation under different flow rates (Vc, Vd) conditions for Liquid - Liquid extraction of aromatics.
System: B-H-80%Dmf -20%W.

Table-(II): Observations recorded for Packed column operation under different sets of conditions for composition of extract phase and raffinate phase.
System: B-H-80%Dmf -20%W.

Table-(III): Selected data for packed column operation on %AE and % PE and NTU values under different sets of conditions. System: B-H-80%Dmf -20%W.

Table-(IV): Mass Transfer data for Liquid - Liquid extraction of aromatics for Packed column System: B-H-80%Dmf -20%W.

(II) Experimental observations and Data Tables for liquid-liquid extraction of aromatics consisting of Feed –Benzene+Hexane as dispersed phase and mixed solvent – Dmso+ Water as continuous phase are reported in Tables – (V) to (VIII).

Table-(V): Observations recorded for Packed column operations under different flow rates (Vc, Vd) conditions for Liquid - Liquid extraction of Aromatics system B-H-

80%Dmso -20%W

Table-(VI): Observations recorded for Packed column operation under different sets of conditions for composition of extract phase and raffinate phase system: B-H-80%Dmso -20%W

Table-(VII): Selected data for packed column operation on %AE and % PE and NTU values under differentsets of conditions for system: B-H-80%Dmso -20%W.

Table-(VIII):Mass Transfer data for Liquid - Liquid extraction of aromatics for Packed column System: B-H-80%Dmso -20%W

(III) Experimental observations and Data Tables for multi stage liquid-liquid extraction of aromatics consisting of Feed –Benzene+Hexane as dispersed phase and mixed solvent – Dmf+ Water as continuous phase are reported in Tables – (IX) to (XI)

Table-(IX): Observations recorded for packed column operations in multistage manner under different flow rate conditions for L-L extraction of aromatics.
System: B-H-80%Dmf -20%W at 30 ^{0}C.

Table-(X): Processing Data Table for selected observations for packed column operation in a stagewise manner for %AE and %PE under different sets of conditions .
system: B-H-80%Dmf -20%W at 30 ^{0}C.

Table-(XI): Values of %AE and %PE in multistage L-L extraction in packed column. System: B-H-80%Dmf-20%W at 30 ^{0}C

(IV) Experimental observations and Data Tables for multi stage liquid-liquid extraction of aromatics consisting of Feed –Benzene+Hexane as dispersed phase and mixed solvent – Dmso+ Water as continuous phase are reported in Tables – (XII) to (XV)

Table-(XII): Observations recorded for packed column operation in multistage manner under different flow rate conditions for L-L extraction of aromatics system: B-H-80%Dmso -20%W at 40 ^{0}C

Table-(XIII) Processing Data Table for selected observation for packed column operation in stagewise manner on %AE and %PE under different sets of conditions System: B-H-80%Dmso -20%W at 40 ^{0}C

Table-(XIV): Values of %AE and %PE in multistage L-L extraction in packed column. System: B-H-80%Dmso-20%W at 40 ^{0}C

(V) Experimental observations and Data Tables for packed column operation in a column of 15 cm diameter for liquid-liquid extraction of aromatics using mixed solvent-Dmf+Water are reported in Tables –(XV) and (XVI).

Table–(XV):Observations recorded for packed column operations under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter. System: B-H-80%Dmf -20%W at 30 ^{0}C

Table-(XVI): Values of %AE and %PE under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter .System: B-H-80%Dmf -20%W at 30 ^{0}C

(VI) Experimental observations and Data Tables for packed column operation in a column of 15 cm diameter for liquid-liquid extraction of aromatics using mixed solvent-Dmso+Water are reported in Tables –(XVII) and (XVIII).

Table-(XVII): Observations recorded for Packed column operations under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter system: B-H-80%Dmso -20%W at 40 ^{0}C

Table-(XVIII): Values of %A_E and %P_E under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter .System: B-H-80%Dmso - 20%W at 40 ^{0}C.

Note :-Sadhana Shukla [152,162] has operated 10 cm dia. and 15 cm dia columns as a direct contact heat exchanger for liquid-liquid heat transfer in the region of dense packing of drops. The same experimental set up was utilized to carry liquid-liquid extraction of aromatics for a very few selected runs for mixed solvents Dmf and Dmso . Newer solvents being costly in nature , only restricted number of runs were taken on large scale due to financial reasons/constraints.

Table-I

Observations recorded for Packed column operation under different flow rates conditions for Liquid - Liquid extraction of Aromatics.
System B-H-80%Dmf -20%W

Sr.No.	Vdo gm/min	Vdi gm/min	Vco gm/min	Vci gm/min	Vcavg gm/min	Vdavg gm/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	VCavg cm/min	Vdavg cm/min
1	3.911	5.640	11.373	10.247	10.810	4.776	0.255	0.366	0.617	0.543	0.580	0.310
2	2.273	2.700	5.800	5.357	5.579	2.486	0.148	0.175	0.315	0.284	0.299	0.161
3	1.700	2.166	4.800	4.441	4.621	1.933	0.111	0.140	0.261	0.235	0.248	0.125
4	1.545	2.547	11.574	10.567	11.071	2.046	0.098	0.165	0.629	0.560	0.594	0.131
5	8.800	10.600	36.620	34.090	35.355	9.700	0.574	0.688	1.989	1.809	1.899	0.631
6	3.833	4.469	11.414	10.174	10.794	4.114	0.250	0.290	0.620	0.540	0.580	0.270
7	1.533	1.541	7.916	7.536	7.726	1.505	0.100	0.100	0.430	0.400	0.420	0.100
8	1.778	2.157	6.444	6.029	6.236	1.823	0.116	0.140	0.350	0.320	0.360	0.128
9	1.901	2.157	8.653	8.290	8.471	1.992	0.124	0.140	0.470	0.440	0.460	0.132
10	4.292	5.394	17.490	16.391	16.940	4.952	0.280	0.350	0.950	0.870	0.900	0.315
11	2.146	2.466	8.285	7.913	8.099	2.209	0.140	0.160	0.450	0.420	0.450	0.150

Table-II

Observations recorded for Packed column operations under differentsets of conditions for for compositions of extract phase and raffinate phase.

System: B-H-80%Dmf -20%W

Sr.No.	VCavg cm/min	Vdavg cm/min	S/F Wt	S/F vol	R.IE	XBE	XHE	XSE	R.IR	XBR	XHR	XSR
1	0.580	0.310	2.264	1.871	1.421	0.100	0.013	0.887	1.425	0.435	0.524	0.041
2	0.299	0.161	2.244	1.857	1.420	0.088	0.002	0.910	1.412	0.371	0.594	0.035
3	0.248	0.125	2.390	1.984	1.421	0.162	0.015	0.823	1.412	0.426	0.550	0.024
4	0.594	0.131	5.411	4.534	1.417	0.069	0.025	0.906	1.404	0.300	0.650	0.050
5	1.899	0.631	3.645	3.010	1.416	0.050	0.025	0.925	1.415	0.370	0.585	0.025
6	0.580	0.270	2.624	2.148	1.416	0.090	0.020	0.910	1.405	0.315	0.670	0.015
7	0.420	0.100	5.132	4.200	1.417	0.058	0.025	0.906	1.391	0.203	0.780	0.017
8	0.360	0.128	3.421	2.813	1.416	0.067	0.015	0.823	1.412	0.364	0.600	0.036
9	0.460	0.132	4.252	3.485	1.416	0.063	0.013	0.887	1.400	0.281	0.677	0.042
10	0.900	0.315	3.421	2.857	1.416	0.060	0.012	0.941	1.414	0.384	0.585	0.031
11	0.450	0.150	3.666	3.000	1.416	0.066	0.018	0.924	1.406	0.320	0.665	0.015

Table-III

Selected data for packed column operations on %AE and % PE and NTU values under differentsets of conditions for system: B-H-80%Dmf -20%W

Sr.No.	Vcavg cm/min	Vdavg cm/min	% AE	% PE	% AE Limiting	Gc $\frac{gm}{min-cm^2}$	Gd $\frac{gm}{min-cm^2}$	HB'1	HB2	Gc/Gd	NTUod	NTUoc
1	0.580	0.310	40.327	88.880	44.000	0.551	0.243	0.603	0.111	2.264	0.832	1.925
2	0.299	0.161	37.807	97.777	42.000	0.284	0.127	0.625	0.095	2.244	0.830	2.200
3	0.248	0.125	45.207	91.520	51.000	0.235	0.098	0.669	0.175	2.390	0.811	2.200
4	0.594	0.131	62.736	73.400	71.000	0.564	0.104	0.364	0.076	5.411	1.570	1.650
5	1.899	0.631	34.547	66.666	50.000	1.802	0.494	0.614	0.054	3.645	0.750	0.780
6	0.580	0.270	46.000	81.818	52.000	0.550	0.212	0.540	0.103	2.601	0.875	2.800
7	0.420	0.100	60.000	69.880	70.000	0.394	0.078	0.404	0.062	5.027	1.530	1.664
8	0.360	0.128	40.500	81.707	55.000	0.318	0.100	0.600	0.073	3.169	0.715	1.425
9	0.460	0.132	51.000	83.444	52.000	0.432	0.103	0.495	0.067	4.175	1.050	1.548
10	0.900	0.315	39.000	83.333	55.000	0.863	0.247	0.611	0.066	3.498	0.670	1.000
11	0.450	0.150	45.000	78.571	50.000	0.413	0.117	0.556	0.071	3.512	0.870	1.400

H'B2= 1.000 **HB1=** 0.700 for all observations.

Table-IV

Mass Transfer data for Liquid - Liquid extraction of Aromatics for Packed column
System: B-H-80%Dmf -20%W

Sr.No.	Vcavg cm/min	Vdavg cm/min	NTUod	HTUod cm	NTUoc	HTUoc cm	$(Koc \cdot a) \times 10^{-3}$ min^{-1}	$(Kod \cdot a) \times 10^{-3}$ min^{-1}
1	0.580	0.310	0.832	142.428	1.925	61.558	9.422	2.177
2	0.299	0.161	0.830	142.771	2.200	53.864	5.551	1.128
3	0.248	0.125	0.811	146.116	1.220	98.220	2.520	0.855
4	0.594	0.131	1.570	75.478	1.650	71.818	8.271	1.736
5	1.899	0.631	0.750	158.000	0.780	151.923	12.500	3.994
6	0.580	0.270	0.875	135.429	2.800	42.321	13.705	1.994
7	0.420	0.100	1.530	77.451	1.664	71.214	5.898	1.291
8	0.360	0.128	0.715	165.734	1.425	83.158	4.329	0.772
9	0.460	0.132	1.050	112.857	1.548	76.550	6.009	1.170
10	0.900	0.315	0.670	176.866	1.000	118.500	7.595	1.781
11	0.450	0.150	0.870	136.207	1.400	84.643	5.316	1.101

Table-V

Observations recorded for Packed column operation under different flow rates (Vc, Vd) conditions for Liquid - Liquid extraction of Aromatics.

System B-H-80%Dmso -20%W

Sr.No.	Vdo gm/min	Vdi gm/min	Vco gm/min	Vci gm/min	Vcavg gm/min	Vdavg gm/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	Vcavg cm/min	Vdavg cm/min
1	25.505	27.884	13.756	13.332	13.544	26.694	1.710	1.810	0.649	0.629	0.640	1.760
2	15.720	17.547	11.657	10.596	11.127	16.634	1.054	1.139	0.550	0.500	0.531	1.097
3	4.340	5.253	13.586	13.089	13.337	4.797	0.291	0.341	0.641	0.618	0.631	0.316
4	3.281	4.468	10.958	10.215	10.586	3.874	0.220	0.290	0.517	0.482	0.500	0.255
5	2.729	3.713	10.640	10.025	10.332	3.221	0.183	0.241	0.502	0.473	0.488	0.212
6	1.864	2.326	9.601	9.326	9.464	2.095	0.125	0.151	0.453	0.440	0.447	0.138
7	3.356	4.391	13.035	12.398	12.716	3.873	0.225	0.285	0.615	0.585	0.600	0.255
8	2.759	3.512	13.353	12.907	13.130	3.136	0.185	0.228	0.630	0.609	0.620	0.207
9	20.762	22.585	11.233	10.449	10.841	21.673	1.392	1.466	0.530	0.493	0.513	1.429
10	3.386	4.529	11.488	10.788	11.138	3.957	0.227	0.294	0.542	0.509	0.527	0.261
11	2.237	4.529	11.827	10.788	11.307	3.383	0.150	0.294	0.558	0.509	0.534	0.222

Table-VI

Observations recorded for Packed column operations under differentsets of conditions for composition of extract phase and raffinate phase.
system: B-H-80%Dmso -20%W

Sr.No.	VCavg cm/min	Vdavg cm/min	S/F Wt	S/F vol	R.IE	XBE	XHE	XSE	R.IR	XBR	XHR	XSR
1	0.640	1.760	0.500	0.363	1.444	0.043	0.009	0.949	1.428	0.524	0.460	0.016
2	0.531	1.100	0.680	0.483	1.447	0.088	0.001	0.911	1.426	0.493	0.480	0.027
3	0.631	0.316	2.780	1.999	1.445	0.047	0.008	0.945	1.419	0.459	0.540	0.001
4	0.500	0.255	2.705	1.961	1.446	0.067	0.004	0.929	1.418	0.456	0.530	0.014
5	0.488	0.212	3.236	2.302	1.445	0.056	0.007	0.937	1.420	0.462	0.530	0.008
6	0.447	0.138	4.470	3.235	1.445	0.048	0.008	0.944	1.408	0.374	0.620	0.006
7	0.600	0.255	3.245	2.353	1.446	0.070	0.004	0.927	1.409	0.383	0.610	0.007
8	0.620	0.207	4.470	2.996	1.445	0.061	0.005	0.934	1.405	0.340	0.640	0.020
9	0.513	1.429	0.590	0.358	1.446	0.080	0.003	0.917	1.428	0.501	0.470	0.029
10	0.527	0.261	2.906	2.018	1.445	0.059	0.005	0.936	1.420	0.470	0.520	0.010
11	0.534	0.200	4.060	2.670	1.447	0.082	0.002	0.916	1.436	0.580	0.410	0.010

Table-VII

Selected data for packed column operations on %A_E and % P_E and NTU values under differentsets of conditions

System: B-H-80%Dmso -20%W

Sr.No.	Vcavg cm/min	Vdavg cm/min	% A_E	% P_E	% A_E Limiting	Gc $\frac{gm}{min-cm^2}$	Gd $\frac{gm}{min-cm^2}$	HB'1	HB2	Gc/Gd	NTUod	NTUoc
1	0.640	1.760	4.200	83.356	11.500	0.690	1.360	0.958	0.044	0.507	0.072	1.208
2	0.531	1.100	11.640	98.871	11.500	0.567	0.848	0.884	0.096	0.669	0.840	4.200
3	0.631	0.316	24.140	85.367	33.000	0.680	0.244	0.759	0.048	2.781	0.207	4.890
4	0.500	0.255	33.000	94.388	35.000	0.539	0.197	0.670	0.072	2.732	0.840	2.544
5	0.488	0.212	32.040	88.871	45.000	0.526	0.164	0.680	0.059	3.208	0.630	2.070
6	0.447	0.138	40.000	86.597	49.500	0.482	0.107	0.600	0.050	4.517	0.010	1.464
7	0.600	0.255	41.500	95.231	44.500	0.648	0.197	0.585	0.073	3.283	0.166	1.464
8	0.620	0.207	46.520	93.149	58.000	0.669	0.160	0.535	0.063	4.187	0.043	2.200
9	0.513	1.429	7.920	96.369	11.500	0.552	1.104	0.921	0.086	0.500	0.480	5.600
10	0.527	0.261	29.726	92.138	40.000	0.568	0.202	0.703	0.062	2.814	0.912	1.000
11	0.534	0.200	42.673	97.611	51.833	0.576	0.172	0.573	0.090	3.342	1.220	2.520

H'B2= 1.000 HB1= 0.000 for all observations.

Table-VIII

Mass Transfer data for Liquid - Liquid extraction of Aromatics for Packed column
system: B-H-80%Dmso -20%W

Sr.No.	Vcavg cm/min	Vdavg cm/min	NTUod	HTUod cm	NTUoc	HTUoc cm	(Koc·a)x10^3 min^{-1}	(Kod·a)x10^3 min^{-1}
1	0.640	1.760	0.072	1645.833	1.208	98.096	6.519	1.069
2	0.531	1.100	0.840	141.071	4.200	28.214	18.810	7.772
3	0.631	0.316	0.207	572.464	4.890	24.233	26.042	0.552
4	0.500	0.255	0.840	141.071	2.544	46.580	10.734	1.807
5	0.488	0.212	0.630	188.095	2.070	57.246	8.524	1.127
6	0.447	0.138	0.010	11850.000	1.464	80.943	5.523	0.010
7	0.600	0.255	0.166	713.855	1.464	80.943	7.412	0.350
8	0.620	0.207	0.043	2743.056	2.200	53.864	11.517	0.070
9	0.513	1.429	0.480	246.875	5.600	21.161	24.223	5.788
10	0.527	0.261	0.912	129.934	1.000	118.500	4.444	2.004
11	0.534	0.200	1.220	97.131	2.520	47.024	11.358	2.285

Table-IX

Observations recorded for Packed column operations in multistage manner under different flow rate conditions for L-L extraction of aromatics.

system: B-H-80%Dmf -20%W at 30 ^{0}C

Sr.No.	Vdo gm/min	Vdi gm/min	Vco gm/min	Vci gm/min	Vcavg gm/min	Vdavg gm/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	Vcavg cm/min	Vdavg cm/min
					Stage -I							
1.1	1.545	2.547	11.574	10.567	11.071	2.046	0.098	0.165	0.629	0.560	0.595	0.132
					Stage-II							
1.2	1.244	1.545	8.661	8.360	8.510	1.394	0.079	0.098	0.471	0.443	0.457	0.088
					Stage-III							
1.3	1.140	1.244	6.833	6.730	6.781	1.192	0.072	0.079	0.371	0.357	0.364	0.076
					Stage-I							
2.1	3.833	4.469	11.414	10.174	10.794	4.151	0.243	0.290	0.620	0.539	0.580	0.266
					Stage-II							
2.2	3.253	3.833	10.636	10.056	10.346	3.543	0.206	0.243	0.578	0.533	0.556	0.225
					Stage-III							
2.3	2.939	3.253	8.850	8.536	8.693	3.096	0.186	0.206	0.481	0.452	0.467	0.196
					Stage-I							
3.1	1.901	2.157	8.653	8.290	8.471	2.029	0.121	0.140	0.470	0.439	0.455	0.130
					Stage-II							
3.2	1.607	1.901	8.376	8.083	8.229	1.754	0.102	0.121	0.455	0.428	0.442	0.111
					Stage-III							
3.3	1.487	1.607	6.955	6.835	6.895	1.547	0.094	0.102	0.378	0.362	0.370	0.098
					Stage-I							
4.1	4.292	5.394	17.490	16.391	16.940	4.843	0.272	0.349	0.951	0.869	0.910	0.311
					Stage-II							
4.2	3.633	4.292	15.343	14.684	15.014	3.963	0.230	0.272	0.834	0.778	0.806	0.251
					Stage-III							
4.3	3.189	3.633	12.875	12.430	12.652	3.411	0.202	0.230	0.700	0.659	0.679	0.216

Table-X

Processing Data Table for selected observations for Packed column operations in stagewise manner for $\%A_E$ and $\%P_E$ under different sets of conditions

system: B-H-80%Dmf -20%W at 30 ^{0}C

Sr.No.	Vcavg gm/min	Vdavg gm/min	Vcavg cm/min	Vdavg cm/min	S/Fwt	S/Fvol	Bextracted gm/min	Bextracted gm/min	%AE gm/min	%AE gm/min	%PE
	Stage -I						Stage	cummulative	Stage	cummulative	
1.1	11.071	2.046	0.595	0.132	5.411	4.534	0.810	0.810	62.736	62.736	73.400
	Stage -II										
1.2	8.510	1.394	0.457	0.089	5.411	4.534	0.301	1.111	65.000	87.261	83.500
	Stage-III										
1.3	6.781	1.192	0.364	0.076	5.411	4.534	0.102	1.213	64.000	95.249	85.600
	Stage -I										
2.1	10.794	4.151	0.580	0.266	2.624	2.148	1.027	1.027	46.000	46.000	81.800
	Stage -II										
2.2	10.3462	3.543	0.556	0.227	2.624	2.148	0.579	1.607	48.000	71.907	92.800
	Stage-III										
2.3	8.693	3.096	0.467	0.199	2.624	2.148	0.289	1.895	50.000	84.830	93.800
	Stage -I										
3.1	8.471	2.029	0.455	0.130	4.252	3.494	0.545	0.545	51.000	51.000	83.400
	Stage -II										
3.2	8.22945	1.754	0.442	0.113	4.252	3.485	0.293	0.839	55.000	77.741	88.400
	Stage -III										
3.3	6.895	1.547	0.370	0.099	4.252	3.485	0.122	0.961	50.000	89.093	92.600
	Stage -I										
4.1	16.940	4.843	0.910	0.311	3.421	2.926	1.049	1.049	39.000	39.000	83.300
	Stage -II										
4.2	15.0137	3.963	0.806	0.254	3.421	2.857	0.659	1.708	40.000	63.347	89.300
	Stage -III										
4.3	12.652	3.411	0.679	0.219	3.421	2.857	0.385	2.094	45.000	77.642	92.700

Table-XI

Values of %A_E and %P_E in multistage L-L Extraction in Packed column

System: B-H-80%Dmf -20%W at 30 ^{0}C

Sr.No.	Vcavg gm/min	Vdavg gm/min	Vcavg cm/min	Vdavg cm/min	S/Fwt	%A_{EI}	%P_{EI}	%A_{EII} cummulative	%P_{EII}	%A_{EIII} cummulative	%P_{EIII}
1	11.071	2.046	0.594	0.131	5.411	62.736	73.400	87.261	83.500	95.249	85.600
2	10.794	4.114	0.580	0.270	2.624	46.000	81.800	71.907	92.800	84.830	93.800
3	8.471	1.992	0.460	0.132	4.252	51.000	83.400	77.741	88.400	89.093	92.600
4	16.940	4.952	0.900	0.315	3.421	39.000	83.300	63.347	89.300	77.642	92.700

Table-XII

Observations recorded for Packed column operation in multistage manner under different flow rate conditions for L-L extraction of aromatics.

System: B-H-80%Dmso -20%W at 40 ^{0}C

Sr.No.	Vdo gm/min	Vdi gm/min	Vco gm/min	Vci gm/min	Vcavg gm/min	Vdavg gm/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	Vcavg cm/min	Vdavg cm/min
					Stage -I							
1.1	15.720	17.547	11.657	10.596	11.127	16.634	1.054	1.139	0.550	0.500	0.531	1.097
					Stage -II							
1.2	14.713	15.720	11.698	10.690	11.194	15.217	0.986	1.054	0.552	0.504	0.528	1.020
					Stage-III							
1.3	13.768	14.713	10.949	10.005	10.477	14.241	0.923	0.986	0.517	0.472	0.494	0.955
					Stage -I							
2.1	3.356	4.391	13.035	12.398	12.716	3.873	0.225	0.285	0.615	0.585	0.600	0.255
					Stage -II							
2.2	2.842	3.356	11.405	10.891	11.148	3.099	0.191	0.225	0.538	0.514	0.526	0.208
					Stage-III							
2.3	2.519	2.842	9.548	9.224	9.386	2.680	0.169	0.191	0.451	0.435	0.443	0.180
					Stage -I							
3.1	2.759	3.512	13.353	12.907	13.130	3.136	0.185	0.228	0.630	0.609	0.620	0.207
					Stage -II							
3.2	2.290	2.759	12.804	12.334	12.569	2.524	0.154	0.185	0.604	0.582	0.593	0.169
					Stage -III							
3.3	2.064	2.290	10.460	10.235	10.347	2.177	0.138	0.154	0.494	0.483	0.488	0.146
					Stage -I							
4.1	3.386	4.529	11.488	10.788	11.138	3.957	0.227	0.294	0.542	0.509	0.527	0.261
					Stage -II							
4.2	2.908	3.386	10.316	9.839	10.078	3.147	0.195	0.227	0.487	0.464	0.476	0.211
					Stage -III							
4.3	2.518	2.908	8.841	8.451	8.646	2.713	0.169	0.195	0.417	0.399	0.408	0.182

Table-XIII

Processing Data Table for selected observations for Packed column operations in stagewise manner for %AE and %PE under different sets of conditions

System: B-H-80%Dmso -20%W at 30 ^{0}C

Sr.No.	Vcavg gm/min	Vdavg gm/min	Vcavg cm/min	Vdavg cm/min	S/Fwt	S/Fvol	Bextracted gm/min	Bextracted gm/min	%AE	%AE	%PE
	Stage -I						Stage I	cummulative	Stage	cummulative	
1.1	11.127	16.634	0.531	1.097	0.669	0.484	1.021	1.021	11.640	11.640	98.871
							Stage II				
1.2	11.194	15.217	0.528	1.020	0.669	0.484	1.008	2.029	13.100	23.127	97.600
							Stage III				
1.3	10.477	14.241	0.494	0.955	0.669	0.484	0.944	2.973	14.000	33.889	98.100
	Stage -I						Stage I	cummulative	Stage	cummulative	
2.1	12.716	3.873	0.600	0.255	3.283	2.353	0.911	0.911	41.500	41.500	95.231
							Stage II				
2.2	11.148	3.099	0.526	0.208	3.283	2.353	0.514	1.425	40.000	64.900	96.150
							Stage III				
2.3	9.386	2.680	0.443	0.180	3.283	2.353	0.324	1.748	42.000	79.642	96.550
							Stage I				
3.1	13.130	3.136	0.620	0.207	4.187	3.004	0.817	0.817	46.520	46.520	93.149
							Stage II				
3.2	12.569	2.524	0.593	0.169	4.187	3.004	0.470	1.287	50.000	73.260	92.140
							Stage III				
3.3	10.347	2.177	0.488	0.146	4.187	3.004	0.225	1.512	48.000	86.095	93.640
							Stage I				
4.1	11.138	3.957	0.527	0.261	2.814	2.022	0.673	0.673	29.726	29.726	92.138
							Stage II				
4.2	10.078	3.147	0.476	0.211	2.814	2.022	0.477	1.151	30.000	50.808	91.140
							Stage III				
4.3	8.646	2.713	0.408	0.182	2.814	2.022	0.390	1.541	35.000	68.025	92.630

Table-XIV

Values of $\%A_E$ and $\%P_E$ in multistage L-L extraction in Packed column

System: B-H-80%Dmso -20%W at 30^0C

Sr.No.	Vcavg gm/min	Vdavg gm/min	Vcavg cm/min	Vdavg cm/min	S/Fwt	$\%A_{EI}$	$\%P_{EI}$	$\%A_{EII}$	$\%P_{EII}$	$\%A_{EIII}$	$\%P_{EIII}$
1	11.127	16,634	0.531	1.097	0.669	11.640	98.871	23.120	97.600	33.880	98.100
2	12.716	3.873	0.600	0.255	3.283	41.500	95.231	64.900	96.150	79.620	96.550
3	13.130	3.136	0.620	0.207	4.187	46.520	93.149	73.260	92.140	86.090	93.640
4	11.138	3.957	0.527	0.261	2.814	29.726	92.138	50.800	91.140	68.020	92.630

Table-XV

Observations recorded for Packed column operations under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter.

System: B-H-80%Dmf -20%W at 30 ^{0}C

Sr.No.	Vdo cm^3/min	Vdi cm^3/min	Vco cm^3/min	Vci cm^3/min	Vcavg cm^3/min	Vdavg cm^3/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	Vcavg cm/min	Vdavg cm/min
1	16.21	27.15	103.8	92.41	98.11	21.68	0.108	0.181	0.692	0.616	0.655	0.145
2	32.710	39.150	83.720	72.750	78.230	35.930	0.218	0.261	0.558	0.485	0.522	0.239
3	19.950	23.120	77.550	72.300	74.920	21.53	0.133	0.154	0.517	0.482	0.501	0.143
4	36.720	47.120	128.400	117,3	122.850	41.920	0.245	0.314	0.856	0.782	0.819	0.279

Table-XVI

Values of $\%A_E$ and $\%P_E$ under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter.

System: B-H-80%Dmf -20%W at 30 ^{0}C

Sr.No.	Vcavg cm^3/min	Vdavg cm^3/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	V_{Cavg} cm/min	Vdavg cm/min	S/F wt. inlet	$\%A_E$	$\%P_E$
1	98.11	21.68	0.108	0.181	0.692	0.616	0.655	0.145	5.36	67.11	78.14
2	78.230	35.930	0.218	0.261	0.558	0.485	0.522	0.239	2.590	50.500	88.350
3	74.920	21.53	0.133	0.154	0.517	0.482	0.501	0.143	3.85	48.81	89.51
4	122.850	41.920	0.245	0.314	0.856	0.782	0.819	0.279	3.480	41.120	89.450

Table-XVII

Observations recorded for Packed column operations under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter.

System: B-H-80%Dmso -20%W at 40 ^{0}C

Sr.No.	Vdo cm^3/min	Vdi cm^3/min	Vco cm^3/min	Vci cm^3/min	Vcavg cm^3/min	Vdavg cm^3/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	VCavg cm/min	Vdavg cm/min
1	173.91	188.11	90.75	82.5	87.62	180.5	1.159	1.254	0.605	0.55	0.584	1.201
2	37.130	47.030	101.470	96.520	99.350	42.330	0.247	0.313	0.676	0.643	0.662	0.282
3	24.970	30.780	85.050	82.210	83.740	27.92	0.166	0.205	0.567	0.548	0.558	0.186
4	30.640	39.690	73.170	68.710	71.110	35.250	0.204	0.264	0.487	0.458	0.474	0.235

Table-XVIII

Values of %A_E and %P_E under different flow rate conditions for L-L extraction of aromatics in a column of 15 cm. diameter.

System: B-H-80%Dmso -20%W at 40 ^{0}C

Sr.No.	Vcavg cm^3/min	Vdavg cm^3/min	Vdo cm/min	Vdi cm/min	Vco cm/min	Vci cm/min	V_{Cavg} cm/min	Vdavg cm/min	S/F wt. inlet	$\%A_E$	$\%P_E$
1	87.62	180.5	1.159	1.254	0.605	0.55	0.584	1.201	0.632	14.15	97.990
2	99.350	42.330	0.247	0.313	0.676	0.643	0.662	0.282	3.042	45.080	96.880
3	83.740	27.92	0.166	0.205	0.567	0.548	0.558	0.186	3.887	49.28	94.640
4	71.110	35.250	0.204	0.264	0.487	0.458	0.474	0.235	2.597	34.190	94.880